Boeing 777

Procedures and Techniques

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This document is based on extensive operational experience and research of the Boeing 777 aircraft types and the embedded EICAS and ECL systems, in conjunction with documented procedures in the Boeing 777 QRH, FCTM and FCOM. Material incorporated into this guide is taken from all three of the relevant Boeing documents, as well as Boeing publications from issues of Airliner magazine and other sources.

This document also describes some of the more common errors encountered during training and checking across two decades of 777 flying. Some of these errors are not necessarily common but contain learning points that are considered valuable for all pilots undergoing recurrent or transition training.

As such the procedures and techniques detailed here are to be regarded as secondary in precedence to all Airline and Manufacturer reference texts and should not be actively referred to with respect to operation of the aircraft.

This document includes screen shots and reference texts taken from various Manufacturer and Airline documentation. These images are illustrative in nature and not up to date or amended – reference to the original documentation is always mandatory.

Additionally, this document incorporates techniques that have been developed and tested in conjunction with Simulator Training but not validated in operation of the aircraft and must be read with caution.

Regards, Ken Pascoe

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Quick Reference

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1. Document Background

1.1. Why a Procedures and Techniques document?

During training instructors and trainees are consistently exposed to normal and non-normal situations that are not experienced during typical line operations. Instructors develop and observe operating practices and techniques that can benefit all crew if communicated in an approved manner to increase the knowledge and understanding of both the normal and non-normal operation of the aircraft.

Included in this body of knowledge is the exposure to repeated and repeatable mistakes and practices that lead to undesirable outcomes in both the training and non-training environments. These common errors can also be communicated to crew to the benefit of general knowledge and improved training outcomes. This document serves to share the benefits of the training experience gained by Airline 777 instructors with line crew.

This document is not to be used as a procedural reference text – for those answers, begin with the Boeing FCOM, FCTM and QRH, augmented by the airline flight operation manual documentation.

This document is background reading and could be considered an historical reference text. If you know your SOPs and are familiar with glass cockpit jet aircraft – much of this document for the most part will merely serve to remind you of them.

Many of the issues discussed here may not be documented in standard operating procedures (SOPs). That does not make them any less valid. What's written here should make you stop; consider; and reach your own conclusions.

Another intent of this document is to give students the opportunity to read about the mistakes observed to have been made by others, so they can go on to make new and completely original mistakes.

Please note that while the document flow vaguely follows a logical flight sequence, within the chapters the sections broadly speaking stand on their own and are not in order. There have been instances where techniques developed in this document become documented procedures in Boeing/Company documentation. As is ALWAYS the case – Company A1, FCOM, FCTM and other "approved" documentation take precedence over the Techniques and (*what may seem like*) Procedures written here.

Finally, in some cases paragraphs are clearly out of order to maximise the efficient layout of the document.

1.2. Procedures vs Techniques

Since this document is as much for Instructors and Examiners as it is for line crew – a quick word on **Procedures** vs **Techniques**.

Procedures

The definition of a Procedure should be pretty clear. A Procedure is documented. A Procedure is printed in a (relatively) permanent fashion; promulgated by a Manufacturer or an Airline Standards Department; a Procedure forms part of a body of documentation that forms the Airline's/Fleet's Standard Operation Procedures (SOPs).

A Procedure does not come from a document downloaded from a web site. A Procedure does not come from the mouth of an Instructor (or Examiner) prefaced by terms like "*I know the manual says this, but I have found a better way of flying this approach is to …*". A Procedure does not come by word of mouth, in an email, or other ephemeral communication medium. A Procedure is the result of significant experience, considerable thought and consideration, and the clear identification of a genuine need for change or documentation. The development and implementation of a Procedure typically comes with risk analysis, often a safety case, simulator testing and review, a period for feedback and comments – and a post-implementation analysis. Making Procedures is hard work, difficult to do really well – and in fact really needs to be difficult. A Procedure needs to either very clearly define or limit the scope for which the it's is designed – or very carefully consider the full scope of the operation in which that Procedure might/should/will be utilised.

Techniques

So … what is a Technique? A technique is … everything else. A technique is every tip every Instructor or Examiner has ever given you that hasn't made its way into formal documentation (*and probably never will*). A technique is a solution to a short-term problem sent out by your Chief Pilot or Training Standards Manager in an email. In many instances – formal communications through Training Standards Notices or Flight Crew Information Bulletins are also Techniques – at least until they reach formal status in documentation. This document is replete with techniques.

Many techniques are firmly rooted in documented procedures, conforming to at least the intent of not the letter of the procedure, but when they vary in specific detail, they become techniques. Many techniques are completely outside the scope of what is covered by existing procedures, providing detail on areas of the operation that either haven't been considered, or in other ways are not clearly covered by procedure. Many techniques are useful, safe, well considered and otherwise valuable to the Pilot, the Crew, the Operation. No airplane gets airborne without techniques – the regime we operate is in the real world, where everything that could happen occasionally does and no body of SOPs can ever anticipate everything. Techniques should be firmly rooted in Airmanship, which is essential to any safe operation. But … do you know where the big difference is?

The Difference is in Assessment

The difference is in Assessment (Examination). Our Training should be to a higher level of *Proficiency* than our Checking – which should be checking for *Competency*. No operation exists without techniques, but in the training environment, any use of technique must be clearly identified by the instructor. A good instructor – like a good pilot – understands the essential value of a good technique, but also clearly delineates between Technique and Procedure when briefing, using, teaching or assessing.

Assessing technique in the checking environment is even more crucial. Since pilots are always going to use techniques in one fashion or another, techniques will form part of the assessment process when checking. But the Examiner should assess the outcome, grade the outcome – not the technique. A root-cause analysis of a flawed performance can absolutely look at the miss/flawed application of techniques as a contributory factor; in some situations, feedback can be given to the Candidate on a good performance involving the flawed use of technique – but the graded performance of the (good) outcome stands.

Note : Currently this document freely mixes the terms Procedures and Techniques in describing the processes, flows and actions contained. As this document is revised, more effort will be made to clarify Procedure (Boeing) from Technique – but in the end it's your responsibility to know your Airline's Procedures back and front in order to identify circumstances where you are appropriately (or not) employing technique.

1.3. Checklist and Checklist Memory Items

In the last few years, Boeing removed the use of the word "**Recalls**" when referring to the memory items on NNM checklists – probably to avoid confusion with the Recall/Cancel switch. Instead these items are now referred to as "**Checklist Memory Items**". Hence when a NNM event occurs that requires the actioning of a checklist with memory Items, crew no longer call for "**Fire Engine Right Recalls**" but "**Fire Engine Right (Checklist) Memory Items**". As much a tongue twister as this is on the flight deck when you're under pressure, it's even more difficult to refer to clearly in print.

As such in this document:

- When you read "**Checklist/Memory Items**" this means Checklists OR Checklist Memory Items (*in other words, Checklists or Recalls*).
- When you read "**Checklist Memory Items**" this means just that – the memory items of a NNM checklist (i.e. "Recalls").

1.4. Nomenclature

The following nomenclature is used throughout this document for consistency.

- Links to sections in this document (such as to the **Table of Contents**) are indicated in purple. These links should be clickable in the electronic version of this document. Note also that clicking on the advisory statement in the footer ("**This is NOT an Operational Document …**") will also take you to the Table of Contents.
- Crew Standard (or Non Standard) Callouts or recommended crew statements are in **Green, Bold Text**.

> If you are reading this document in GoodReader note that after clicking on a link that takes you to a place within the document - dragging backwards on the screen with three fingers restores you back to the link you clicked on.

- Flight mode annunciations are indicated as such – **THR LNAV VNAV SPD**
- EICAS Messages are indicated as ❑ **WARNINGS**, ❑ CAUTIONS, ❑ _ADVISORY, **MEMO** or **(ANNUNCIATED) CHECKLIST TITLES** (CAPS) or **(Unannunciated) Checklist Titles** (Sentence Case)
- Crew Positions used to describe either positions on the flight deck (or simulator) or roles in the SOPs or decision making vary from operator to manufacturer.
  - Captain, CA, Left, CM1, Pilot in Command, Aircraft Commander
  - First Officer, FO, Right, CM2, Second in Command, Relief Commander
  - 1st Observer, Primary Relief Crew Member (PRCM), CM3, Second Officer (SO)
  - 2nd Observer, Secondary Relief Crew Member (SRCM), CM4, Second Officer (SO)

1.5. Further Resources

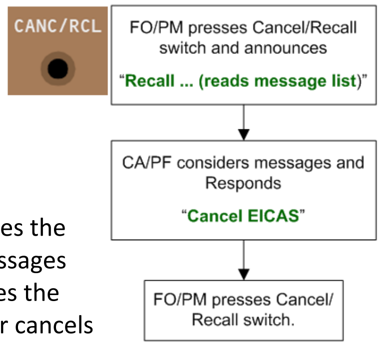
I have started including links to articles, videos and other items of relevance in this document. These are (currently) still the purple links. So, some of the **purple links** take you to places in this document – some take you elsewhere on the internet. I'll fix up that confusion in the next issue.

Infinidim.Org

Infinidim is my personal web site where many of the content in here begins (often in vastly expanded, diary manner). There is also some personal stuff and musings on other areas of interest. I have also started creating training presentations on my personal YouTube channel **here**.

2. General Observations

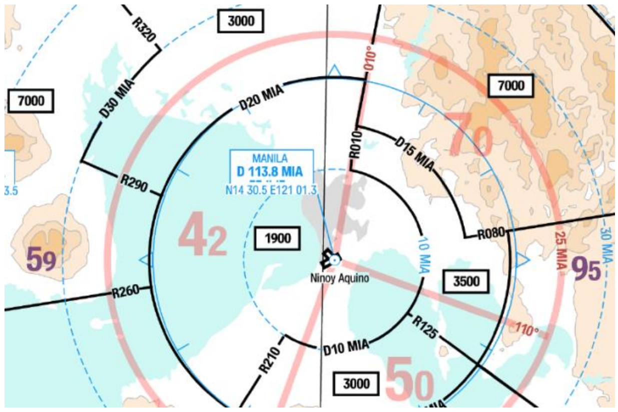
2.1. Recall During Flows



There are several EICAS **Recalls** during flows, such as Before Start, After Start and prior to the Descent Checklist. Procedurally these are actioned by the PM (or First Officer) but require the involvement of the PF (or Captain). The correct procedures for all EICAS/ECL handling are documented in **EICAS / ECL Normal Procedures** and **EICAS/ECL – Non Normal Procedures** of this document.

A correctly executed Recall begins with a clear EICAS display. PM/First Officer presses the Recall/Cancel switch, calling out the white "**Recall**" message from the EICAS. PF/Captain verifies the annunciated "**Recall**" as displayed on EICAS – which confirms that the first page of EICAS messages is being displayed. PM/First Officer reads out the displayed messages, while PF/Captain verifies the messages and if willing to accept the next stage of flight, calls "**Cancel EICAS**". PM/First Officer cancels the EICAS (*potentially, one page at a time*) and continues the flow. If there are no messages associated with the "**Recall**" the appropriate response is (*of course*) "**Check**".

2.2. ATC Make mistakes



It is an oversimplification to say that pilots tend to manifest a belief in the infallibility of ATC. That said – simulator experience indicates that this seems to be the case. One lesson that comes from operational experience is that ATC **can** direct you into terrain; ATC **can** direct you into other aircraft; ATC **can** direct you into severe weather.

It is also even more accurate to say that in the **simulator** – your "ATC" guy **will** direct you into hills, other aircraft and weather.

It is the pilot who is responsible for terrain clearance at all times. It is also the pilot who wears the consequences of any lack of vigilance in this regard. This includes during radar vectoring. Areas of the world with a history of terrain clearance issues often provide a MVA or MRC chart to enable pilots to cross check position with a minimum radar vectoring altitude. However, the non-existence of a MVA/MRC chart does not infer that mistakes have not been made in radar vectoring.

At any time during the flight a crew should be able to quickly determine a safe minimum altitude for the aircraft – particularly during climb and descent.

PF : "**Cleared Below MSA**" … **PM** : "**Check**"

There is a standard call intended to highlight the fact that the aircraft has been cleared below MSA. The intent of this call is not just to highlight the point at which the aircraft descends below MSA – but to raise the situational awareness of the crew that it has been cleared to descend below MSA and is about to do so. This call is made when ATC clear the aircraft below the relevant Sector/Segment/Area MSA while the aircraft is not on a final instrument approach glide path.

2.3. PF Does The Rudder Trim

The rudder trim control is in the PF's area of responsibility in flight. There is a technique that has been taught at various times during engine failures after takeoff where the PF is encouraged to call for the PM to trim the rudder, when the workload on the PF is high and the aircraft close to the ground. This technique is discussed elsewhere (**EFATO – Trimming**) – but in any case, it does not apply at any other time. When an engine and the TAC fail at altitude, trimming the rudder is the responsibility of the PF. PM trimming the rudder is the exception, not the rule.

2.4. Glass Cockpit Scan

Apart from the PFD and ND, the EICAS and to a lesser extent the CDU (scratchpad) should also be in a Pilot's scan. When an instructor sees trainees who are technically under low workload levels not noticing an EICAS advisory message for several minutes (*bearing in mind it's the instructor who generated the message*), it's usually a sign of a poor scan technique and SA.

The scan of the ND should include reference to the current leg and active waypoint. It should be considered unusual to have an ND display for an extended period that does not show the active waypoint. The ND will of course be used tactically to avoid weather - and at times enroute waypoints across the Pacific that are 500+ nautical miles apart may not allow for keeping an active waypoint up.

In any event - keep your ND Map Scale at a value that promotes situational awareness – not detracts from it. Getting airborne in the sim with a 10 mile scale and keeping it there for the next ten minutes is just asking your instructor to place a CB 20 miles ahead …

2.5. Two heads down – In General

This is probably one of the most common errors of a highly automated flight deck. The PF should be acutely aware of any tendency to watch what the PM is doing instead of flying the aircraft, and especially aware of assisting in the PM duties, instead of flying the aircraft.

A degree or two heads of down will be tolerated, even encouraged during early simulator type rating training in order to maximise crew exposure to the lessons being taught, but as the crew moves into FFS, the simulator should be treated as an aircraft and two heads down studiously avoided as the flight safety risk that it is.

2.6. Altimeter Subscale Setting

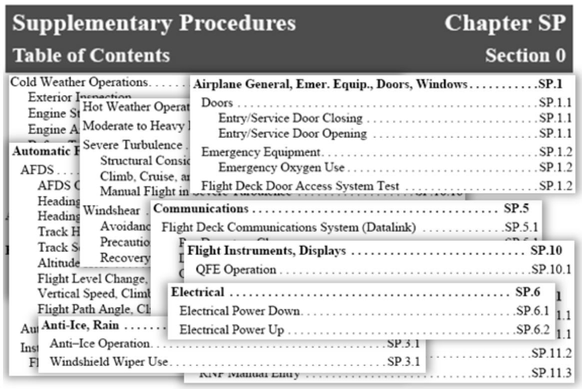
Altimeter subscale setting and the subsequent cross check is crucial beyond the importance accorded to it in SOP's and Flight Operations Manuals. Incorrect subscale settings have caused accidents in the past. RNAV/GNSS approaches in particular are highly susceptible to incorrect altimeter settings – see **Non-Precision Approach With Incorrect QNH**. Transition and the subsequent crosschecks, along with QNH changes and a subsequent altimeter cross check should be given a high priority, even in a busy flight deck – it's part of **Fly The Plane**. Additionally, most Flight Operations Manuals require multiple checks against separate sources for QNH. Typically, this means obtaining a METAR/ATIS of the aerodrome QNH prior to being given it by ATC.

That said, remember that in the 777 during normal operations (*no system degradation*), the cross check is the subscale (x3) only (**Pre-Flight Checklist – Altimeters**) and not an altimeter altitude indication readout check.

2.7. Altitude Selector 1000 vs Auto

By habit the altitude selector should be left in the 1000 position. This is by far the most common usage when selecting altitudes (by 1000's). If a non x1000 intermediate altitude or MDA needs to be set, then selector should be moved to Auto, the altitude set, then the selector placed back in the 1000 position.

2.8. Supplementary Procedures



The Boeing FCOM incorporates a number of Supplementary Procedures which cover the range of aircraft supplementary operations. Some of the Supplementary Procedures include procedures that are run by the crew on a step by step basis, some provide background information to a process that crew perform regularly by memory.

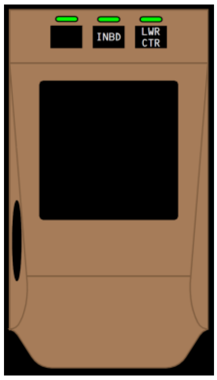
In many cases Supplementary Procedures should be reviewed by the crew (as a crew) prior to the actual need for the procedure. With procedures such as those associated with Engine Starting a good technique is to review the relevant procedure as part of the "Operational" component of the Departure briefing. A general knowledge of the procedures and information topics that exist in the FCOM supplementary is an important component of 777 flight operations.

You can't call for the correct SP if you don't know what it does, or that it exists.

2.9. Check/Brief FMC to Chart

When briefing or checking the FMC against a Chart (STAR/SID/Approach) crew should work ***FROM the FMC LEGS page TO the relevant chart***. This removes confirmation bias in seeing on the LEGS page what the chart has led you to expect. It also develops an important skill in being able to look at a LEGS page and determine what LNAV and VNAV are going to do. If you find it a challenge working FMC -> Chart – it's a skill you need to develop.

2.10. Using The CCD



Occasionally you may find yourself getting into trouble with the ECL by accidentally clicking on the wrong prompt when running a Normal (NM) or Non-Normal (NNM) checklist. Much of the problem here is the touchpad area of the CCD – or more specifically, your tendency to fondle it.

If you look at it objectively – when using the ECL, any requirement to actually move the cursor using the CCD is rare, mostly down to choosing an Unannunciated checklist, or selecting in a Yes/No branch – in all other circumstances the cursor jumps to the next line, the next page, the next prompt – functioning well without your ~~interference~~ input.

So … the best way to operate the ECL is to keep your thumb on the side button, and your finger off the CCD until it's absolutely needed. And slow down.

2.11. C'mon Mav, time to do some of that Pilot …

Pilots new to the aircraft tend to be enamoured with the FMC and the Automation (*especially once they begin to understand it*), at times to the exclusion of common flying-the-plane sense, particularly in a training environment. For example:

You are level at 9000 ft after departing Sydney (*in* **VNAV ALT** *for those who look at their FMA*). It's 09:56 UTC and ATC want to know if you can reach FL150 by time 1000z. How can you find an answer to this?

- You can look at the legs page. If there's a waypoint near the time 1000z, it may have a crossing altitude that will tell you what altitude the FMC is planning you at for that time. That'll be pretty close.
- You can place FL150 in field 6R on the Fix page. This will give you a distance to run to that point on your present track. You can then convert that distance to an altitude using a magical formula that I haven't thought of yet.
- You can change your cruise altitude to FL150. Then the FMC will give you a time at top of climb on the Progress and VNAV CLB pages.

Or you could verbalise something like "**Ok, six thousand feet in four minutes means 1500 fpm to FL150 – if we keep 250 knots, not a problem – tell them - Yes.**" Turn and Burn.

2.12. Checklists and Checklist Memory Items You've Never Seen

The Boeing Type Rating course is reasonably complete. It's certainly considered complete by the regulator, who certify crew as type rated as the result of successfully completing the course. But it certainly does not cover all the available non-normals, nor practice and evaluate all of the Checklists and NNM manoeuvres present in the QRH and FCTM.

So if you front up to a refresher course having been signed out on your Type Rating, OPC/IR check – and encounter an event in which you are required to action a checklist with memory items, or fly a manoeuvre you don't know, because you haven't seen it in the simulator – whose fault is that?

As a general principle, students on transition course should also consider all Unannunciated Checklist titles and condition statements as memory items along with the memory items in all checklists. Action items associated with manoeuvres such as the Terrain Escape Manoeuvre and Windshear are also to be memorised.

2.13. Read the Glass!

Dating back to the **First Implementations** of EFIS in the modern flight deck came the admonishment to "**Read The Glass!**" This simply stated concept has a complex underlying philosophy that professional aviators do well to take to heart in today's flight deck. In essence when looking at the information in front of you, you should always be looking for the end of the logic chain; the end result of your selection; the information coming out of the computers – rather than the selections going in. Some examples might help here.

You've set a higher altitude and selected FLCH on the MCP to initiate a climb to higher altitude. You can see the numbers in the altitude selector and the light in the FLCH switch – so it's done isn't it? But your autopilot doesn't see the MCP. So look at the selected Altitude on the PFD (top RHS, magenta); and look at the FMA to see if your MCP Mode Selection has resulted in **THR … FLCH SPD**

When you run the **BEFORE START CHECKLIST**, you're required to verify a whole series of switch and selector positions. As you look through the following list – where have you been looking while responding to the checklist – and where should you be looking to verify using "**Read The Glass!**"?

BEFORE START CHECKLIST

☐ Flight deck door	.... Closed and locked	F/O
☐ Passenger signs	............................AUTO, ON	C
☐ MCP	.... V2 ___, HDG/TRK ___, ALT ___	C
☐ T/O speeds	.... V1 ___, VR ___, V2 ___	C
☐ CDU pre-flight	..............................Completed	C
☐ Fuel	.... ___._ Tonnes	C
☐ Trim	.... ___ Units, 0, 0	BOTH
☐ Taxi and T/O briefing	.....................Completed	C
Transponder	.... TA/RA	F/O
Beacon	.... ON	C

- **Flight Deck Door** ....**Door Control vs Flight Deck Door Lock Panel**
- **Passenger Signs**......... **PASS SIGNS Selectors vs EICAS Memo Message**
- **MCP** .... **MCP Selections vs PFD indications**
- **T/O Speeds**........................ **CDU Entries vs PFD V1 / MCP Selected V2**

This is not to say that that you shouldn't look at selector positions, the CDU, the MCP when verifying selectors and selections. But in all cases where there's glass you <u>could</u> be looking at – you <u>should</u> be looking at it.

The thinking EFIS aviator extends this concept to seek the glass whenever verifying selections and values in the modern glass flight deck.

2.14. Cold Temperature Corrections

Aircraft altimeters and altimetry systems are calibrated for ISA conditions. When the OAT deviates from ISA, an indication error occurs in the altimetry information provided to the pilots as well as the barometric altitude reference passed along to the FMC and other systems. The 777 FMC does not currently have the ability to correct for non-ISA temperature deviations.

Deviations from ISA in terms of Altimetry are referenced against a ground-based temperature source – typically the temperature on the ground at the departure or destination airport. While it may not be entirely accurate, a uniform deviation is assumed from the ground to the level of the aircraft.

Airport Temp °C	Height Above Altimeter Reference Source											
	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	1500 feet	2000 feet	3000 feet
0°	20	20	30	30	40	40	50	50	60	90	120	170
-10°	20	30	40	50	60	70	80	90	100	150	200	290
-20°	30	50	60	70	90	100	120	130	140	210	280	420
-30°	40	60	80	100	120	140	150	170	190	280	380	570
-40°	50	80	100	120	150	170	190	220	240	360	480	720
-50°	60	90	120	150	180	210	240	270	300	450	590	890

The size of cold temperature altimetry errors is proportional to:

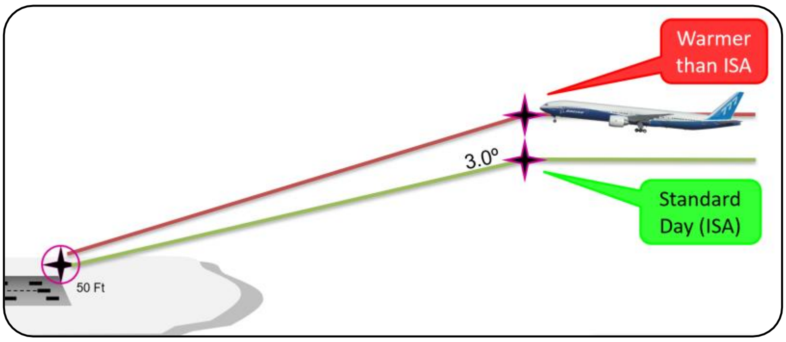
- The degree of variation from ISA; and
- The height of the altitude being corrected above the ground temperature source (above airport elevation).

As shown here from the Boeing FCOM Supplementary Procedures, for a fixed deviation from ISA **the correction required increases with altitude**. For a fixed altitude, the correction required **increases with decreasing airfield temperature**.

Note that ATC provided radar vectored altitudes do not require pilot correction for cold temperature conditions.

Warmer than ISA

In warmer than ISA conditions, the altimetry system **under-reads**. When the aircraft is flown by reference to a barometric source (*whether driven by the pilot/autopilot using the altimeter or the FMC using a barometric reference*) the aircraft is invariably actually higher than that indicated on the altimeter. An approximate rule of thumb is 0.3° approach angle for every 15° temperature above ISA.



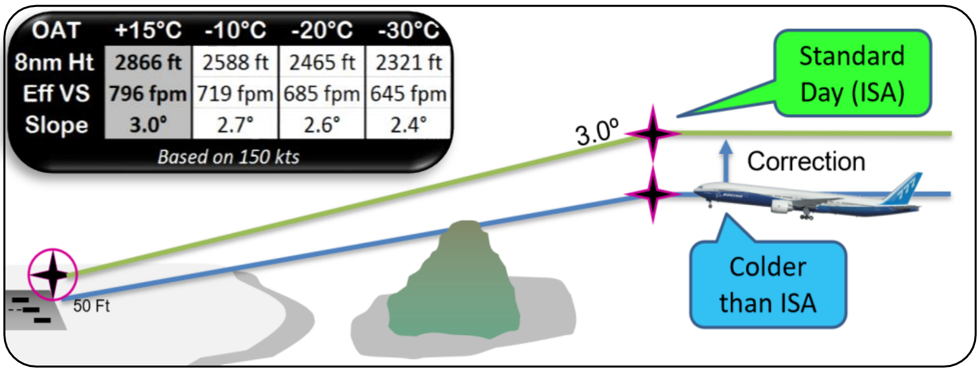
For a **Non-Precision Approach** (*whether driven by the pilot/autopilot using the altimeter or the FMC using it's barometric reference*) the aircraft will be higher than indicated. Since the error decreases with descent, the height above a 3° slope decreases also until the aircraft is only a few feet above the required threshold crossing height. In effect the aircraft starts the approach high, descending on a steeper effective angle than promulgated by the instrument approach, resulting in a slightly higher descent rate and less thrust required. If a visual guidance system is provided the indications will show high on slope to the threshold (*see below*).

For **Precision Approaches** (*whether ILS or GNSS based*), the aircraft flies the commanded 3° (*or otherwise*) slope down to the runway and threshold crossing height. For such approaches, the altimeter will under-read since the aircraft is actually on slope, but the altimeter indication itself is impacted by the ISA deviation. This is often noticed at the outer marker crossing height check during precision approaches to warmer temperature airports.

Boeing do not require corrections for warmer than ISA temperatures, and this information is provided for guidance only.

Colder than ISA

In colder than ISA conditions, the altimetry system **over-reads**. When the aircraft is flown by reference to a barometric source (*whether driven by the pilot/autopilot using the altimeter or the FMC using it's barometric reference*) the aircraft is invariably actually **lower** than indicated. This can lead to unsafe clearance from terrain in relation to all minimum safe altitudes in the departure, arrival, approach and missed approach phases of flight. Boeing require low temperature corrections when the ambient airport temperature is at or below 0°C



Correcting Minima – Non APV

Almost all barometric based minima require cold temperature corrections for ambient airport temperature at or below 0°. Given that the correction is based on height above airport, it's usually pretty small. This includes Precision and Non-Precision approaches. If you are going to look at your altimeter at the bottom of your approach (*as opposed to your DA Rad Alt*); then you're going to need to correct the minima your using for Cold Temperature Altimetry. The exception to this is … APV.

Correcting Minima - APV

Approaches with Vertical Guidance (APV, including RNAV GNSS/GPS to LNAV/VNAV DH; RNP-LNAV-VNAV and RNP AR) incorporate a sloped obstacle clearance surface (OCS) from the FAF down to the end of the approach (*minima, MAP, or runway*). Typically, quite a bit flatter than the 3° we're aiming for. The lower angle of this slope can be equated to flying the approach in a (very) cold temperature, and this is often the basis of the minimum temperature present on these charts (*see below*). The DH minima on these approaches are protected by the OCS from cold temperatures – down to the minimum temperature specified on the chart.

Basic Modes using FPA in Non Standard ISA Temperatures

When Flight Path Angle (FPA) is used in non-standard ISA temperature conditions, a higher approach angle (warmer conditions) or lower approach angle (colder conditions) is required to commence an approach from an un-corrected initial altitude. This is typically required for NPA's in high temperatures. For low temperature corrected NPA's the promulgated glide path angle should be used with FPA since the aircraft is at the corrected height above the runway, despite the altimeter indications.

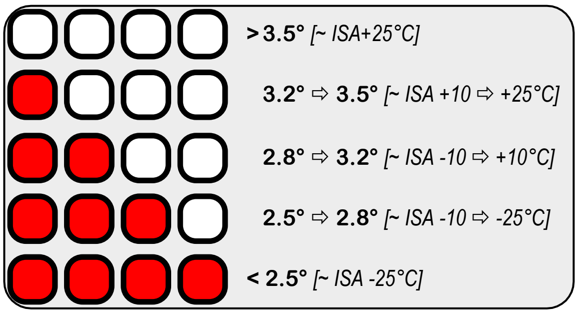
SIDs and STARs

Minimum Safe Altitudes (MSA), Lowest Safe Altitudes (LSALT) and minimum altitudes on SIDs and STARs may need to be corrected in cold (Airport Temp ≤ 0°C) conditions. Corrections are based on the Boeing FCOM SP chart with extrapolation in accordance with the guidance provided. Corrections are made based on the ambient airport temperature and the height of the minimum altitude above the airfield elevation. Deviations from charted altitude constraints due cold temperature corrections must be communicated to ATC. Note that some FMC constraints cannot be cold temperature corrected (such as conditional altitudes).

Airport Temp °C	Height Above Altimeter Reference Source											
	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	1500 feet	2000 feet	3000 feet
0°	20	20	30	30	40	40	50	50	60	90	120	170
-10°	20	30	40	50	60	70	80	90	100	150	200	290
-20°	30	50	60	70	90	100	120	130	140	210	280	420
-30°	40	60										
-40°	50	80										
-50°	60	90										

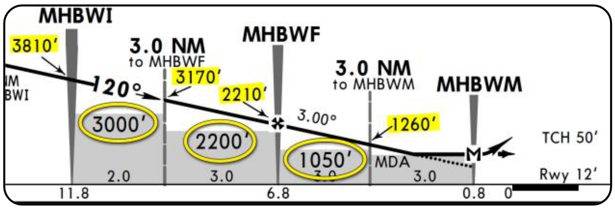
Visual Slope Guidance

From a barometric based approach, in non-standard ISA conditions the aircraft will be higher (warmer) or lower (colder) than the promulgated instrument approach and any provided visual approach slope guidance system. The error decreases as the aircraft reduces height above the ground and the aircraft approximates a steeper (warmer) or flatter (colder) approach path, which is maintained to the threshold. This deviation from the visual guidance system approach angle will be reflected in the visual approach slope systems indications – unless you are flying the PAPI/VASI as your primary reference.



The values shown here are approximates for a PAPI system aligned at 3° slope and are for guidance only.

FMC & VNAV in Cold Temperatures



Outside of the CDU LEGS page final approach angle, the FMC drives VNAV vertical path commands through the use of the on-board barometric reference systems, which are subject to cold temperature errors. As such for all such instrument approaches, <u>if VNAV is going to be used the FMC LEGS page altitude constraints will require cold temperature corrections</u>. Crew should appreciate the difference between adjusting these altitudes to ensure clearance from terrain (*yellow ovals*) vs restoring the programmed aircraft flight path to that intended by the approach design (*yellow highlight*). Strictly speaking, the Boeing FCOM requires corrections to ensure clearance in respect of the **altitude constraints**, although correcting crossing altitudes is a similar procedure. Deviations from ATC cleared altitudes for cold temperature corrections must be communicated to ATC.

Once past the FAF, the FMC follows a path dictated by the geometric angle indicated in the LEGS page, as restricted by any constraining LEGS page higher altitude. However, the FMC is fundamentally a barometrically driven device, and while a geometric angle is indicated on the LEGS page, in fact the FMC converts this to a barometric path based on the end of path lateral and vertical co-ordinates. As such the FMC flies the LEGS page slope by reference to altimetry and is subject to temperature error. Since this error is magnified by deviation from ISA and height above the airport:

- In warmer conditions the FMC will start the final approach high and fly a steeper slope.
- In colder conditions, the FMC will start the final approach low and fly a flatter slope.

With a corrected FAF (or later) altitude constraints, the FMC calculates a steeper approach angle to meet this increased constraint altitude requirement. Since the barometric temperature error reduces with descent, these corrections will result in the FMC approximating the original promulgated approach angle (*while believing it is flying the steeper angle*).

<u>**In Short**</u> : While nominally on a glidepath – the FMC / **VNAV PTH** flies a barometrically calculated glide path that is subject to non-ISA temperature altimetry error.

Constraints that typically require correction are At, At-or-Above, and At-or-Below. Below (only) constraints do not require cold temperature corrections.

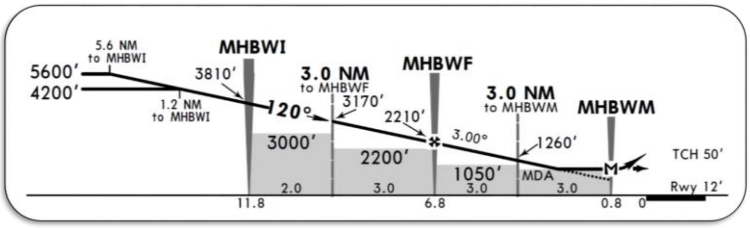
Non-Precision Approach (LNAV Only Minima)

In cold temperature conditions, all constraint (*crossing*[1]) altitudes require correction from the IAF, through the FAF, the Minima (*whether MDA or DA*) and the missed approach. Having corrected CDU LEGS page altitudes in the approach through to the missed approach, ensure you start again and work back through the corrections before execution to ensure they are still correct. Accidentally entering an incorrect (*too high*) altitude can delete previous waypoint altitudes, which aren't re-instated when you fix your error in the waypoint you are working on.

Note that many missed approach paths include conditional altitudes that cannot be corrected, and some FMC's do not allow corrections to missed approach altitudes when they are at or above the current FMC cruise altitude. Finally, if a turn depends on a conditional altitude waypoint, you may well need to use **TRK SEL** to extend lateral flightpath until reaching the corrected altitude, coming out of LNAV in the missed approach.

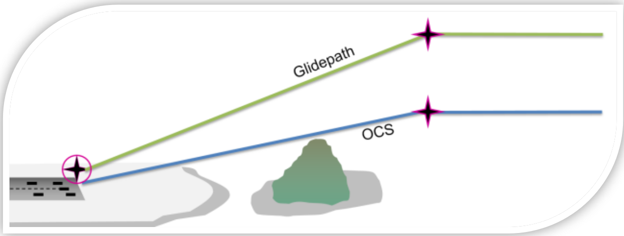
Airport Temp °C	Height Above Altimeter Reference Source											
	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	1500 feet	2000 feet	3000 feet
0°	20	20	30	30	40	40	50	50	60	90	120	170
-10°	20	30	40	50	60	70	80	90	100	150	200	290
-20°	30	50	60	70	90	100	120	130	140	210	280	420
-30°	40	60	80	100	120	140	150	170	190	280	380	570
-40°	50	80	100	120	150	170	190	220	240	360	480	720
-50°	60	90	120	150	180	210	240	270	300	450	590	890

<u>**Note**</u> : All corrections to the FMC LEGS page have a significant potential safety impact on the approach and <u>must</u> be double checked by both pilots.



[1] Note that technically crossing altitudes could be left uncorrected if the aircraft will remain above the associated temperature corrected constraint altitudes. In this case you'll be flying a lower, flatter approach, but still clear of terrain.

Approach with Vertical Guidance (APV) including RNP-AR



APV approaches differ from standard NPAs in that they are constructed similarly to precision approaches with a sloped Obstacle Assessment Surface (OCS) in the final approach segment, rather than the traditional step-down criteria shown on such charts. These approaches must be flown in LNAV and VNAV, typically to a Decision Altitude (DA) rather than an MDA.

When these approaches are flown in cold temperature conditions, the final approach slope altitudes do not require correction, and the approach is flown from a lower FAF altitude on a shallower approach. The instrument approach chart includes a minimum ambient (airport) temperature below which the lower, flatter approach is not guaranteed to be clear of the OCS. When the ambient (airport) temperature is below the charted minimum, a reversion to LNAV only minima is usually available – the charted LNAV/VNAV minima must not be used.

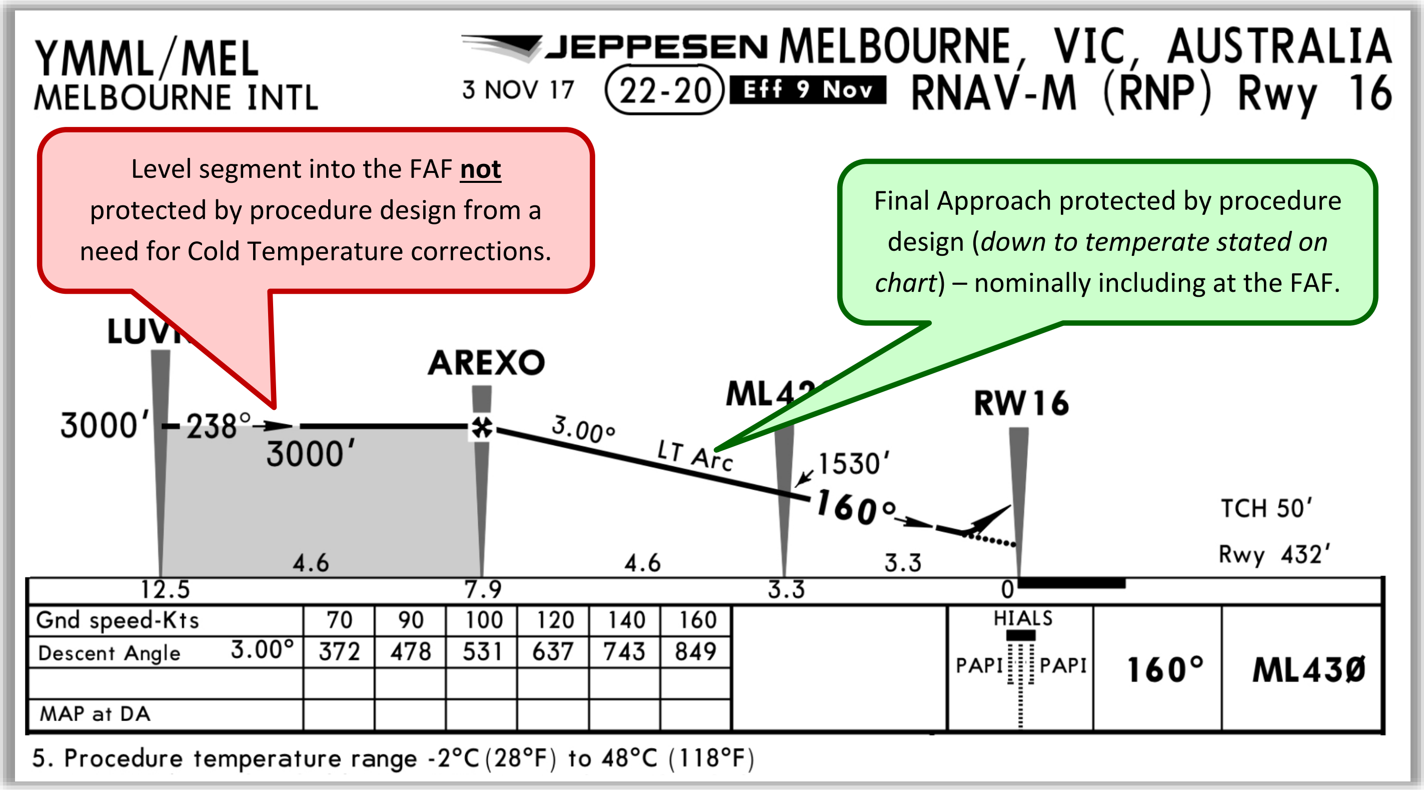
STRAIGHT-IN LANDING RWY02L

	LNAV/VNAV DA(H) 450′(428′)		LNAV MDA(H) 540′(518′)	
		ALS out		ALS out
A	RVR1400m	RVR 2200m	RVR 1200m VIS 1200m	RVR 1600m
B				
C			RVR 1600m	RVR 2400m
D			RVR 2000m	RVR 2800m

However for APV approaches, cold temperature corrections are required to all altitudes outside the final approach – IAF, IF and other constraints as well as the Missed Approach. The FAF constraint itself does not require correction, nor any altitude constraint in the LEGS page after the FAF down to the Missed Approach Point (MAP). That said – the minimum safe altitude flown by the aircraft into the FAF (*which is often dictated by the FAF crossing/constraint altitude*) will require cold temperature correction.

Alt Set: hPa Rwy Elev: 1 hPa Trans level: FL 130 Trans alt: 11000′
1. Minimum temperature for which Baro-VNAV operations are authorized: 5°C (41°F).
2. Maritime vessels of variable heights in water north and south of runway.

On APV approaches, the minima (DA) does not require cold temperature correction – you are clear of terrain down to the minimum temperature specified on the chart, colder than which the approach (minima) is invalid anyway. Without a correction, you will be lower on the approach when you make your Continue/Don't decision – but still clear of terrain.



QNH Errors

All barometric based instrument approaches are highly susceptible to errors in QNH setting. See **Non-Precision Approach With Incorrect QNH**.

3. Auto Flight

3.1. Calling FMA

All FMA changes (*including mode arming*) should be called. This begins with the "**Thrust Ref**" call after FMA **THR REF** is engaged during the takeoff roll, through to the last FMA change above 200 ft on approach, normally "**Land Three, Rollout and Flare armed**" after 1500 ft AGL. Typically (*expected*) FMA Changes are not called below Minima (*or during Flare/Rollout during an Autoland*).

3.2. Don't throw the aircraft at the Autopilot

It would be somewhat unusual for a pilot to raise the nose to 20°, roll in 35° of bank, close the thrust levers and call across to the other pilot "**You have control.**" Well, outside a simulator anyway. Apart from anything else, it's rude. However there seems to be no such inhibition when it comes to throwing the aircraft at the autopilot.

> BOEING
>
> **AFDS Guidelines** — 777 Flight Crew Training Manual
>
> Autopilot engagement should only be attempted when the airplane is in trim, F/D commands (if the F/D is on) are essentially satisfied and the airplane flight path is under control. The autopilot is not certified nor designed to correct a significant out of trim condition or to recover the airplane from an abnormal flight condition and/or unusual attitude.

The Boeing FCTM requires that the aircraft be **in trim** (*this includes rudder*) and **satisfying the commands of the Flight Director** prior to AP engagement. Those of you who have handed the aircraft over to the autopilot when neither of these requirements were being met, only to have the AP then disengage (*you know who you are*) – are effectively demanding more of the AP than it can cope with.

Typical examples of poor AP engagement behaviours are observed after TCAS RA or Windshear recovery where FMA modes are inappropriate for the flight path required, the FD's are not being followed, but the aircraft is thrown at the auto pilot anyway. A similar principle holds for the engagement of LNAV – it's recommended to sort out your LNAV path in the FMC (so that you're on it or setup to intercept) before arming/engaging (throwing at) LNAV.

3.3. What is A/T HOLD?

Auto-throttle **HOLD** mode is the equivalent of the auto-throttle saying to the PF "**You Have Control.**" At this point, the A/T is still armed and can potentially re-engage without an associated Thrust and/or Pitch FMA change, but basically the A/T has set a thrust (*usually, but not necessarily* **IDLE**) and has then taken its "hands" off the thrust levers. The PF can increase or decrease thrust to modify the rate of descent (*such as during FLCH Descents*).

HOLD engages when FLCH is used, after FLCH has set a higher/lower thrust calculated to achieve the altitude change. At this point the PF can move the thrust levers at will, increasing or decreasing the rate of climb or descent as desired. It's worth nothing that prior to this, moving thrust levers against FLCH will usually force a reversion to **HOLD**. Again, this is a design feature intended to allow to pilot to manually set a rate of climb/descent during otherwise automated FLCH SPD operations.

HOLD is quite critical on takeoff when the A/T annunciates **HOLD** just after 80 knots. By this stage, required takeoff thrust must have been set in order to satisfy the performance calculation requirements of the takeoff. Crucially, if the Captain decides after this point an increase in thrust is required, Captain can advance the thrust levers to increase thrust without fighting or disconnecting the A/T.

3.4. HDG SEL then Select Heading

When Heading/Track Select is engaged, the AFDS initiates a turn towards the heading/track bug **in the shortest direction of turn**. This means if the crew are executing a near 180° turn and do so by first setting the heading bug, then engaging heading select – the aircraft could well turn in the wrong direction. Note however that once HDG/TRL SEL is engaged, if the PF spins the Heading/Track selector around past 180°, the HDG/TRK SEL mode will maintain the initial direction of turn and chase the HDG/TRK bug around the compass points.

For this reason, it is good practice to engage heading select before turning the heading bug. Note however that crew should not engage heading select without first having an awareness of where the heading bug is and which way the AFDS will turn. Since one of the tasks of the PF (*or PM during manual flight*) is keeping the heading bug in synch, it should all go swimmingly well …

3.5. THR or THR REF

There is a subtle difference in the A/Thr modes of **THR** vs **THR REF**. When in Thrust Reference, the Autothrottle commands the limit thrust setting (CLB/CON/TO, etc) – such as on Takeoff, Go-Around or when FLCH/VNAV calculates maximum thrust is required for the manoeuvre. When less than a full limit thrust is required, such as descent or shorter FLCH climbs - **THR** is used. You should be able to predict whether the FMC will go **THR** or **THR REF** before you press the MCP mode selector …

3.6. VNAV as a Tactical Mode

Generally, VNAV is not good for those tactical speed/altitude changes. The MCP is where you want to be implementing those short-term vertical flight pitch changes, unless it's changing cruise level in a low workload environment.

For example, when told to limit your speed on climb until a certain level, there is a small advantage of VNAV – you can set 230/15000 in the CDU VNAV CLB page and the aircraft will accelerate by itself as you climb through FL150 (*all else being equal*). However, this is considered a small benefit as opposed to the heads down requirement of implementing this in the FMC at low level (*below 10,000 AGL*) and the increased opportunity for error this introduces into the Flight Deck.

Generally speaking – use the MCP for lower level vertical path (speed/altitude) changes. Just don't forget to keep that change in your mind if you have to cancel it later.

3.7. Keep pressing that Altitude Selector … NOT

When an instructor sees a student needlessly pressing the altitude selector after a selected altitude change, it can be an indicator of several things. Primarily automation confusion, but it is also often an indication of a lack of AFDS situational awareness. There are generally four reasons to press the altitude selector after an MCP selected altitude change.

- The aircraft is in **VNAV ALT** or **VNAV PTH** and the PF wishes to initiate a climb/descent.
- The PF wants to delete the next LEGS Page Speed/Altitude restriction from the FMC. As long as this (altitude) restriction is between the aircraft's current altitude and the MCP Altitude Selector, each single press will delete that Altitude (*and any associated speed constraint*) from that waypoint – whether the aircraft is in VNAV or not.
- The pilot needs to change the Cruise Altitude in the FMC Cruise Page, based on the MCP Altitude Selector.

The most common error is level flight in basic (non VNAV) modes, a new altitude is selected, and the PF presses the altitude selector to commence the climb/descent. The habit of pressing the altitude selector needlessly can cause difficulties during instrument departures/arrival and when commencing a Non-Precision Approach as the PF can un-intentionally delete an altitude restriction from the LEGS page, including at the IAF (*or elsewhere on the STAR/approach*).

If you press the selector in error – a good habit is to check that you haven't accidently deleted a LEGS page restriction. Your instructor will assist you in this. When you hear "**One (more) Beer …**" coming from the back of the sim you'll know you've pressed the MCP Altitude Selector without justification … even if it did give you that feeling of being part of a team …

3.8. Before you engage that mode …

Crew should not select an AFDS mode without an awareness of what flight path changes will result from the associated mode engagement. As obvious as this may sound, crew new to the Boeing AFDS have a tendency to "throw" AFDS mode changes at the aircraft. Considerations for the various mode engagements are detailed in this table.

AFDS Mode	Considerations
HDG SEL TRK SEL	• Where is the Heading/Track Bug? • Which way will the aircraft turn? • Are you in Heading or Track reference?
FLCH	• Where is the Altitude Selector set? • Are we going to Climb or Descend? • What will be the Thrust FMA/Thrust Limit?
LNAV	• Where is the active waypoint? • Where is the active flight leg? • Am I on an intercept for the planned leg? • Is LNAV going to ARM or ENGAGE?
VNAV PTH VNAV SPD	• Is the FMC in CLB, CRZ or DESC mode? • If DESC – is it in Approach mode? • Where is the VNAV Profile at this point? • What speed will VNAV command? • So, what will the aircraft do?
APP Modes LOC / GS	• Is the ILS Tuned / Identified? • What are Localiser/Glideslope indications? • Are you expecting Arming or Engagement?

In many cases, the selection of AFDS modes is the result of a process following an ATC instruction and the considerations here are superfluous. In the case of VNAV, often insufficient automation knowledge exists to anticipate the result of mode engagement, so you just hope it works.

To clarify, if you can't predict the FMA and Thrust Limit setting before pushing a button – you don't know your aircraft and you have some study to do. During my initial transition on the B744 (*about 30 years ago*), my fixed based instructor required me to announce the FMA change BEFORE I was allowed to press the AFDS modes on the MCP. He was ahead of his time, and a sadist.

Remember when you're about to engage heading select, the information you need to know is on the PFD/ND heading bug indication. When you're about to engage FLCH, the information you need to know is the selected altitude on your PFD.

When you're about to engage LNAV, the information you need is on the ND – the active waypoint, the active leg, the aircraft position. When you're about to engage VNAV, the complete picture is partly PFD – current altitude, selected altitude – but mostly the VNAV CDU page – whichever one (CLB/CRZ/DESC) pops up when you press the CDU VNAV switch.

3.9. Flight Level Change and SPEEDBRAKE EXTENDED

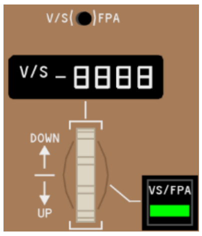
Often the PF will select FLCH for a smaller altitude change (*descent generally less than 3000 ft*) and subsequently commence Speedbrake extension to increase the rate of Descent. Occasionally this will result in a SPEEDBRAKE EXTENDED Caution Message and Beeper. At this point the PF realises that the thrust levers are at an intermediate thrust setting (THR or HOLD); instead of IDLE – hence the EICAS Caution.

It's worth noting that a FLCH descent is not necessarily an idle thrust mode. FLCH determines a thrust setting based on the level change requirement. Smaller level changes (generally requiring less than three minutes to complete) will result in an intermediate thrust setting. This can be determined from the THR annunciation on the AFDS, rather than either IDLE or HOLD.

The solution to FLCH/Descent/SPEEDBRAKE EXTENDED is generally to follow through on the thrust levers during FMA mode changes and close the thrust levers manually prior to extending the Speed brake lever. More often than not this will result in a reversion from THR to HOLD as you take over the thrust control from FLCH. This can be an important thing to remember when being required to intercept the **Glideslope Intercept From Above.**

The thrust setting calculation performed by FLCH works this way for climbs as well. FLCH may well set less than the current thrust limit in order to achieve a level change in (approximately) two minutes.

3.10. VS : (Not So) Very Special Mode



There is a perception that VS (and by association, FPA) is somehow an AFDS mode with inherent flight safety implications and should only be used as a last resort. Generally speaking this attitude stems from a poor understanding of the AFDS VS/FPA mode. While FLCH is usually superior in most situations to VS, there are a number of situations where VS is highly appropriate.

It is true that VS has some issues related to airspeed. These issues are inherent in the design of the mode – unlike FLCH and VNAV SPD, the primary controlling parameter is not IAS. As such, IAS is sacrificed where necessary to maintain the primary controlling influence of Vertical Speed. Therefore VS/FPA can be inappropriate at high altitude (*and/or high weight*) when thrust is insufficient and airspeed may reduce towards minimum manoeuvring margin. Very high VS selections in either climb or descent can result in inappropriate speed excursions.

VS/FPA however **is** a mode of choice for:

- Reducing rate of climb or descent when approaching an altitude/level and other aircraft are in the vicinity.
- Non-Precision Approaches when VNAV is not available.
- Continuous Descent Arrivals.

Mach not IAS at High Altitude

One specific issue is the use of VS or FPA at high altitude. Engaging VS/FPA from VNAV opens the speed window to the current IAS indication. VS/FPA level changes with IAS as the parameter commanding elevator at high altitude is inherently risky – the MCP airspeed selector should be changed to MACH.

3.11. Altitude Capture near Transition

Anytime there is an altitude requirement near Transition – re-setting the altimetry subscale setting to QNH/Standard with a significant change (>7mb) near the requirement can result in more than usual pitch control forces as the AFDS tries to cope with the change – or an altitude violation if the AFDS is unable to do so.

Altitude Capture

In principle ALT Capture (*VNAV or Basic*) is a pre-calculated manoeuvre the AFDS (*whether AP or FD*) calculates based on a variety of parameters to determine where (altitude) the capture manoeuvre commences, and the pitch change forces involved.

There are several parameters involved, including existing rate of climb/descent and the limits of pitch authority VNAV is allowed to exert on the flight controls. If the pre-conditions subsequently change (*such as a significant subscale change*) then VNAV can push/pull more heavily (*but always within limits*) than typically occurs during a normal capture; or the altitude requirement can be breached. The usual solution is to be situationally aware to the developing scenario and change the subscale setting early.

VNAV PTH Requirement

When a CDU LEGS page requirement near transition restricts the VNAV Path, changing the subscale setting significantly forces a path deviation, requiring the AFDS to manoeuvre to re-capture the path. Depending on climb/descent vs high/low QNH changes – the path change energy requirement can be in excess of that available to VNAV/AFDS to action. The two obvious solutions are to either change transition early to allow VNAV time to accommodate the path change – or modify the altitude requirement in anticipation of the change requirement.

3.12. VNAV without LNAV, without ... VNAV

LNAV/VNAV work best when engaged together. Assuming a correctly programmed FMC, LNAV takes care of the lateral track, calculating turning radii for turn constraints and intercepts, flyby and flyover waypoints, all while providing accurate distance/speed data for the calculation of fuel, time and descent path.

Meanwhile VNAV – when the aircraft is following the programmed LNAV track and assuming reasonably accurate wind data – will calculate the most efficient descent path and vary indicated airspeed when necessary to maintain that path – without altering selected (ECON) descent speed. Speed/Altitude constraints At/Above/Below or a combination thereof are complied with irrespective of the MCP altitude setting – when a constraint can't be met, the crew are informed in a timely fashion, for the most part. LNAV and VNAV work great in harmony together.

Then there's what happens when you split them up ...

LNAV without VNAV

LNAV without VNAV generally works fine - however it's been observed that crew sometimes forget their vertical profile is no longer being guarded by the LEGS page constraints – particularly when the engaged LNAV FLCH SPD climb/descent happens to comply with the calculated VNAV Path. If the MCP altitude selector is not set correctly, and compliance with vertical constraints not monitored, altitude clearance violations and off path deviations can result.

VNAV without LNAV

VNAV without LNAV seldom makes sense – particularly when the aircraft is in VNAV PTH. In this case the calculated descent path is being maintained based on a projected lateral path ***that the aircraft is no longer following***. Inevitably either more or less track miles are involved in the calculated descent and VNAV PTH makes less and less sense. In addition, the aircraft may level off unexpectedly for altitude constraints on a flight leg that bears no resemblance to the actual lateral tracking of the aircraft – or when Flap 1 is extended on descent below the calculated VNAV Path. Updates and changes to the LEGS page can further corrupt the VNAV Path calculation. It is highly unusual for VNAV PTH to be the correct vertical mode when not following the associated LNAV track – ideally with LNAV engaged.

VNAV SPD without LNAV is somewhat better in that at least the aircraft is usually descending in IDLE/HOLD (*a fixed thrust setting*) and the implication is that the PF is monitoring vertical path. Speed Control (*and the option of additional thrust when the auto throttle is in* HOLD) is at the behest of the PF - in this case one remaining trap here is that the VNAV PTH can re-engage by itself with (*or without*) LEGS page changes and now you're in VNAV PTH without being in LNAV and on the LNAV track again.

4. Flight Management Computer

4.1. FMC Changes : "Confirm" … "Execute"

Strictly speaking, all FMC changes that result in the activation of an Execute light should move the PM to call "**Confirm?**" to the PF, and upon verification, the PF should respond "**Execute**". Trainees tend to be fairly good in this regard when all is quiet at altitude and operations are normal, but this highly recommended safety/situational SOP requirement tends to be abandoned when the pressure is on during NNM events. **This is exactly the time when the confirmation of FMC changes should involve the other pilot.**

Another aspect of the **Confirm … Execute** technique is that it tends to separate the roles of the two crew members on the flight deck – one pilot makes the change, the other approves it, and we avoid both pilots being heads down at the same time.

A useful tip for the PF when confirming Direct To's that don't easily show on the ND (*such as when a significant distance away*) is for the PF to briefly switch to PLAN mode on the ND. Usually this will show the Direct To waypoint centrally on the screen with the dashed white modification line leading straight into it for a quick, accurate confirmation of the pending modification. Ensure the correct ident has been used however and gross error check the distances involved (*thanks Kev*).

Note that it's often crucial for the PF to look at the CDU LEGS Page 1 to determine whether a route change will affect the immediate navigation of the aircraft – especially when LNAV is engaged. There are changes to FMC navigation that can't be easily verified from the ND – the relevant LEGS page should always show the next waypoint LNAV is tracking to before executing.

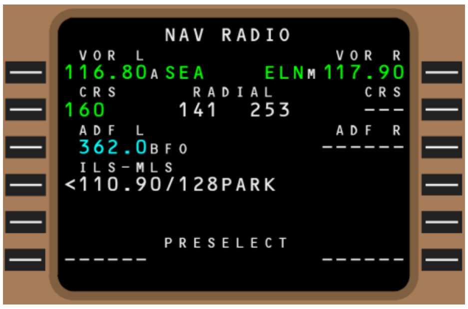
- Route Changes after the current waypoint
- Selection of STAR/Approach/Runway
- Modification to LEGS while established or tracking to a holding pattern
- Intercept Course To modifications
- Alternate Page Divert-To execution (see **ALTN Page – DIVERT NOW**)

4.2. Two heads down – FMC

Contrary to popular belief (*and observed behaviour in the simulator*) – **it only takes one pilot to make a change to the FMC.** In fact, changes to the FMC seem to occur faster, with less error and a more positive post-change / pre-execute cross check, when only **one** pilot is involved in making the entries.

So as the PF, resist the temptation (*especially during training, altitude/level changes, approach, non-normals and other high workload activities*) to get involved in the PM's manipulation of the FMC. Be patient – PM will find the right page eventually, and probably learn more from the self-discovery experience as well. When prompted "**Confirm?**" – do a positive cross check that the changes are as requested before confirming "**Execute.**" As the PF, isolating yourself from active involvement in the process of modifications to the FMC helps enforce your role as an independent arbiter of the changes made.

4.3. Navaids : To AutoTune or Not AutoTune …



Choosing to manually tune the VOR's for departure and arrival is usually a personal choice. However, the following factors should be taken into account when deciding to manually tune the VOR's (*and thereby disable AutoTune for that receiver*):

- The FCTM advises that the "preferred" method for tuning/final approach course selection is FMC ***procedural*** tuning.
- Generally, AutoTune will select the correct aids based on the SID/STAR/Approach/Missed Approach programmed in the FMC. However, if you fly a procedure that is not stored in the FMC database, AutoTune may not be helpful.
- Usually the Left VOR will tend to tune forwards, the Right VOR will tend to keep over flown VOR's active a while longer (*very subjective*).
- Sometimes a better alternative to manual tuning is to back up AutoTune with appropriate pre-selects, ready for selection in the event that AutoTune does not function as desired.
- Some crew advise using VOR frequencies in the pre-selects rather than navaid identifiers. This means that in the event of a double FMC failure, the pre-select frequencies will work (*Navaid Idents would not be recognised by the CDU*). This is fine as far as it goes, however the more likely event is an AutoTune problem, and the Navaid Idents tend to be easier to recognise when trying to get back an Aid after an AutoTune problem than the frequencies.
- AutoTune is not perfect – often it tends to tune forwards when the PF would prefer to retain the over flown aid. The times and places this occur become known to crew who remember to include raw data in their scan ...
- Manual Tuning is perfectly acceptable and within the responsibility of the PF (*PM should be made aware*). Typically, manual tuning is employed when a particular procedure has a known associated history of undesirable AutoTuning.
- Try to remember to restore the AutoTuning once Manual Tuning is no longer required.

4.4. Hold Page when Holding

Ideally the FMC Hold page should be displayed on a CDU (*typically the PF side*) when entering a holding pattern, and while holding. If the CDU is required for another purpose then it should be used at the requirement of the crew, then returned to the Hold page when no longer required. The crew who keeps the Hold Page up on a CDU tends to be the one that remembers to activate **EXIT HOLD>** before it's too late.

4.5. ALTN Page – DIVERT NOW

Unless you are being radar vectored back to your departure airport, the ALTN page is the quickest and most complete method for setting up a diversion in the FMC. The **DIVERT NOW>** prompt clears out all the legs page entries except that waypoint required to return (*if it was entered and/or selected prior to Divert-To*) and sets the new destination airport in the Route page, which gives access to the STARS and approaches for the airport.

A common error associated with this FMC feature is the deletion of the active waypoint the PF is using in LNAV – or the holding pattern the aircraft is currently flying. A hold about to be deleted is one of the things not show on the ND during a pending execution.

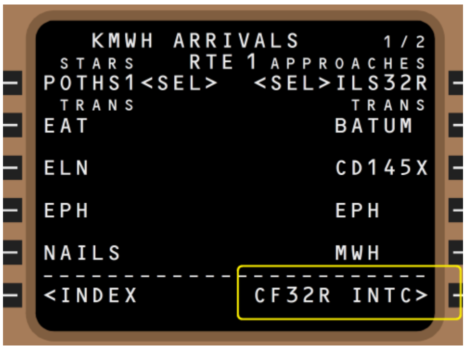
Most commonly **DIVERT NOW>** is used to:

- Route direct to the airport identifier (eg: YSSY); or
- Route first to a waypoint that is already on the LEGS page (*not necessarily the active waypoint*) then the diversion airport identifier.

Best practice is to use the **DIVERT NOW>** prompt on the individual airfield page of the ALTN page, to verify the choice of diversion waypoint prior to selecting the feature. Ensure either **DIRECT TO** or **OVERHEAD XXX** has been selected (**<SEL>**) as desired by the PF.

Finally, when the Execute light is lit – **a check of the LEGS page on the CDU** (*either PF or PM side*) gives a last chance opportunity to save the Hold or Active Waypoint that wasn't supposed to be deleted – especially if LNAV is engaged.

Final Course Intercept and LEGS Page Crosscheck



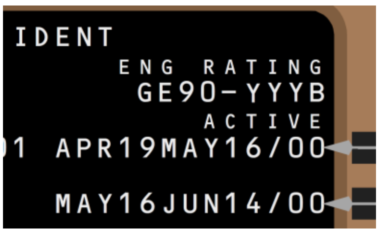
Interestingly, this last LEGS page check is what the FMC forces on you when you use the Final Course INTC (*Intercept*) feature from the DEP ARR page. This feature also deletes all LEGS page waypoints prior to the nominated fix, and establishes an inbound final approach course to a database selected final approach course fix.

As soon as this feature is selected, the pilot is automatically shown the LEGS page so the destruction of the flight plan can be confirmed prior to execution. Unfortunately, Honeywell did not implement this feature in the **DIVERT NOW>** feature logic – so you should do it.

4.6. Inserting Waypoints into SIDs, STARs, Approaches

Nominally there are a few issues with inserting additional waypoints into a SID or STAR. In the days of navigation via navigation aids this could potentially result in unpredictable Navaid Autotune behaviour. The insertion of any additional waypoint before/after a conditional waypoint or a fly-over waypoint can also have unpredictable results. Inserting waypoints after the commencement of the glidepath angle on the CDU LEGS page can disrupt the FMC glidepath and subsequently the operation of VNAV PTH. There are specific prohibitions on most NPA's – especially RNP AR.

4.7. FMC NAV Database Swapping



Occasionally it can be useful to completely clear out Route 1/2 from the FMC. An example of this would-be fault-finding Datalink uploading of Routes and other data. Occasionally an uplinked route can come to Route 2 (instead of Route 1) and remain there with a LOAD> prompt that is not obvious to the pilots. Rejecting (or loading) this Route can clear up the FMC buffer.

One sure-fire method to clear out all navigation related information in the FMC is to cycle the active database between the active and other one. Ensure you return the FMC to the correct database! This action will completely remove everything in Routes 1 and 2. It's something of a blow-torch solution however, so be prepared to thoroughly check anything you have already entered - don't take anything for granted.

4.8. FMC Default Pages

There are some recommended pages for the FMC CDU at various stages of flight. These are NOT mandatory. If a pilot wishes to use another page with better information relevant to the situation at hand, this is good airmanship and is to be encouraged. However, experience has found that certain pages offer the best access to information and automation management in certain phases of flight.

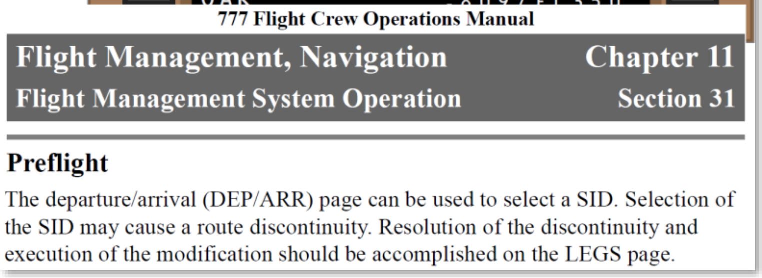
Note that poor CDU page selections for significant amounts of time are indicative of poor scan rate and lowered situational awareness on the part of either or both pilots.

Flight Stage	Recommendation	Reasoning
Pre-Flight Performance Entry	CDU-L : PERF INIT	After CDU Pre-Flight, but prior to final load notification, if the Captain keeps the Left CDU on PERF INIT page, this assists in remembering to enter the performance data.
Taxi Prior to the Departure Review	CDU-R : RTE Pg 2	Displayed for the SID identifier (*or lack thereof*) in the Departure Review.
	CDU-L : TAKEOFF REF	Displayed for the Flap, Runway and V_1 / V_2 in the Departure Review.
Take off	PF CDU : TAKEOFF REF; or VNAV CLB	The Boeing FCTM recommends the TAKEOFF REF page for the take-off roll in the event that the PF needs quick reference to the takeoff speeds. Experience has also proven the value of the VNAV CLB page, giving the target speed airborne (V_2 +25) as well as the first waypoint with an altitude/speed restriction in the departure. Note that once airborne, a single press of the INIT REF key will display the THR LIM page for quick access to alter the climb thrust limit selection.
	PM CDU : LEGS	The LEGS page gives the PM quick access to departure routing changes, as well as both pilots an overview of the speed and altitude constraints on the departure.
Cruise	PF : VNAV CRZ	Generally, the PF will keep the VNAV CRZ page displayed when no other page is required. This gives access to cruise altitude related information such as Maximum, Optimum, Recommended and predicted Step Altitudes.
	PM : LEGS	By default, the LEGS page is usually displayed by the PM. Some crew prefer the PROGRESS page or LEGS RTE DATA for time and fuel estimates.
Descent	PF : VNAV DESC	The VNAV DESC page gives the PF quick reference to descent speed, speed transition and the next waypoint speed/altitude limits. Reference is often made to the PROGRESS pages for distance to run to destination for height/distance cross checks.
	PM : LEGS	The venerable LEGS page gives the PM (*and PF*) access to incoming speed/altitude restrictions as well as giving the PM quick access for arrival routing changes.
Holding	PF : RTE HOLD	When slowing to holding entry speed and while established in the hold, it is recommended for one CDU to display the RTE HOLD page.
Approach	PF : VNAV DESC ; PROGRESS P2	VNAV DESCENT gives the Waypoint Speed/Altitude restrictions, as well as Waypoint VB/VS/FPA information. PROGRESS Pg 2 gives VNAV profile deviation, as well as Tail/Cross Wind components and LNAV deviation.
	PM : LEGS	LEGS page for speed and altitude restrictions, particularly during NPAs is recommended.

For example …

"**Flap 15 Departure** (CDU/EICAS/Flap Lever); **Runway 16** (CDU/ND); **V_1 161** (CDU/PFD0; **V_2 178** (CDU/MCP/PFD); **TOGA-TOGA, LNAV/VNAV Armed**; **Track 160 for the EOSID**; **DOSEL 8 Departure**. **Departure Review Complete**."
(CHKL – Displays the **BEFORE TAKEOFF CHECKLIST**).

4.9. Route Discontinuities are our Friend


777 Flight Crew Operations Manual

Flight Management, Navigation — **Chapter 11**
Flight Management System Operation — **Section 31**

Preflight

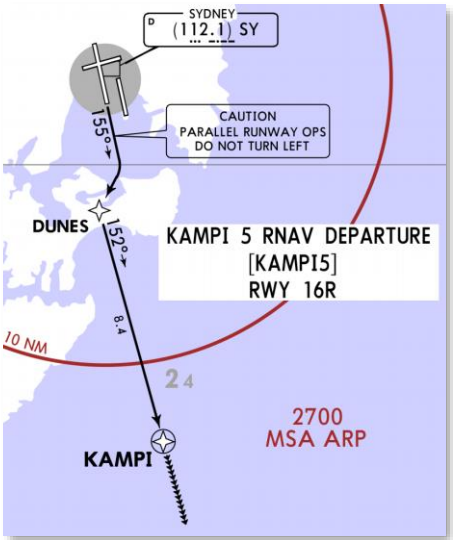
The departure/arrival (DEP/ARR) page can be used to select a SID. Selection of the SID may cause a route discontinuity. Resolution of the discontinuity and execution of the modification should be accomplished on the LEGS page.

There is a misconception that route discontinuities are a bad thing that must be removed from the flight plan during pre-flight or during approach preparation.

The Boeing FCOM does not help in gaining an appreciation of the usefulness of route discontinuities, advising that all discontinuities should be cleared. This is a fairly simplistic view of what is actually a very useful tool in the real-world airline environment.

Route discontinuities come about because one part of the route does not meet up with a subsequent part of the route. Often this occurs for a very good reason.

Common on departure is the discontinuity after a SID that does not meet up with the CFP route – the Sydney RW16R KAMPI departure for example. Before removing any discontinuity – crew should ask themselves "**Why is it there?**" In the case of the KAMPI departure, the question is more correctly "**What do I want the aircraft to do after KAMPI?**" The SID is designed such that the aircraft should be given a vector, or cleared direct to an enroute waypoint prior to KAMPI. But in the event this does not happen – what would you want the aircraft to do? What would ATC expect you to do? If you remove the discontinuity, the aircraft will turn and track towards the next waypoint (*for example, WOL on the way to Melbourne*), which may not be the best course of action.



What happens if the aircraft flies into a discontinuity? The CDU scratchpad displays **ROUTE DISCONTINUITY** and an associated EICAS Advisory **FMC MESSAGE** will display. LNAV will remain engaged, as will the autopilot. The AP/FD will command straight ahead. Essentially the aircraft keeps flying, but communicates you have a problem to solve. Perfect.

Another common cause of route discontinuities is data problems with uploaded flight plans. An historical example would be flights planned enroute over Ayers Rock. The identifier for both the NDB and the VOR at Ayers Rock was AY. Since the CFP uplink could not determine which waypoint to use, the FMC would instead insert a discontinuity, using neither. Crew would close the discontinuity without determining the reason for it (*or cross checking the CFP correctly*) and the FMC would contain the uplinked flight plan without Ayers Rock. The aircraft would fly across the area without Ayers Rock being reported through CPDLC and ATC would file a report. When the entire sequence was contained within an airway structure without AY being a transition point between airways – this was an easy mistake to make.

Another common use of discontinuities is during descent phase. For airfields without published STARS, the CFP and airways clearance will often plan for the aircraft to track to the primary aid at the airfield – usually the VOR. Experience tells you to expect to be vectored from about 20 miles towards a downwind position. A PBD waypoint (VOR/-20), followed by a route discontinuity, then the instrument approach can leave you with a legs page that will comply with your clearance (*even after the discontinuity, it will continue to track towards the VOR*) but provide the FMC with the right track miles to provide a reasonable VNAV descent profile. If you get to 20 miles without a vector – AP/FD commands straight ahead and you are informed of the problem via scratchpad/EICAS.

The long and the short of route discontinuities is – they are there to be used and when used, should be briefed as to the intent of the discontinuity and the action that will be taken as it is approached.

4.10. FMC Scratchpad Messages

The CDU scratch pad is the FMC's prime method of trying to tell you something. Messages like "**UNABLE HOLD AIRSPACE**" or "**TAKEOFF SPEEDS DELETED**" or "**ROUTE DISCONTINUITY**" are the FMC's way of communicating a problem to the crew – a problem that is valid, even if the crew don't understand the message. It's not uncommon to see crew clear those messages with minimal acknowledgement, a habit that unfortunately commences during simulator training.

CDU Scratchpad messages need to be dealt with like any other annunciation in the flight deck. Noticed, Called, Analysed, Acted Upon. Some of the more common(ly ignored) FMC messages are listed here.

Airline SOP Standard Calls should require the Captain/First Officer/PF/PM to confirm a scratchpad message with the other pilot prior to clearing a message. This requirement commences once the pre-flight initial First Officer setup / Captain cross check is complete.

While there are scratchpad messages which are all but inconsequential to flight (**STANDBY ONE** or **INVALID ENTRY**) and there are messages which are commonly understood and occur routinely (**INSUFFICIENT FUEL** [during route changes]; **UNABLE HOLD AIRSPACE**; **UNABLE CRZ ALTITUDE; DRAG REQUIRED** or **UNABLE RTA**) there are also messages which can have a significant impact of flight path and flight safety (**DISCONTINUITY**; **INSUFFICIENT FUEL**; **RW/ILS FREQ/CRS ERROR**; or **TAKEOFF SPEEDS DELETED**).

Finally, a smart pilot may not choose to clear an FMC CDU Scratchpad Message – but instead retain the message in the scratchpad until the underlying cause has been corrected. The CDU is fully functional while a scratchpad message is displayed with any data entered into the scratchpad line replacing the message until that data is either line selected into the CDU or cleared, at which point the message is returned – if it's still valid. An example of this could include "**NOT ON INTERCEPT HEADING**" when LNAV has been armed but the aircraft is not tracking towards an active leg – correcting the aircraft track will clear the scratchpad message; leaving the message in the scratchpad until the intercept heading is established is a useful error trap. A complete list of FMC/CDU messages and their meanings can be found in the Boeing/Honeywell 777 FMS Guide. Have a look – some of them are pretty obscure.

FMC/CDU Message	Meaning
INSUFFICIENT FUEL	Because of a change in flight conditions or the route, the computed route fuel burn exceeds the total fuel on board, less reserves. Is there a valid reason for this?
UNABLE HOLD AIRSPACE	The radius of the holding pattern, calculated by the FMC, exceeds the FMC maximum protected airspace limits. How will you deal with this? Perhaps it's time you slowed down for the hold? Have you considered the Landing Weight yet?
UNABLE CRZ ALT	Performance predicts a zero cruise time at the entered cruise altitude. This commonly occurs when the FMC was in VNAV CLIMB mode but has now calculated the programmed Cruise Altitude is not feasible (diversion/return). The FMC has in effect just transitioned to VNAV DESC mode and should begin to calculate a descent path. This is a Good Thing, and not something to be "fixed" by playing around with the FMC Cruise Altitude.
RW/ILS CRS ERROR **RW/ILS FREQ ERROR**	Either the airplane is within ILS automatic tuning range and the tuned ILS frequency/course does not match the frequency/course for the active arrival runway, or the FMS is not receiving valid course data from the same ILS that the FMS is using for frequency data, or valid frequency data from either ILS.
TAKEOFF SPEEDS DELETED	Performance related FMC changes can cause the FMC to drop previously selected/entered takeoff speeds. Crew will need to re-run the Performance Entry procedure to account for the change and re-enter the takeoff performance data.
CHECK ALT TARGET	VNAV is selected when the aircraft is between the MCP window altitude and the VNAV target altitude. VNAV holds level flight.
VERIFY POSITION	The current FMS calculation of airplane present position is based on conflicting data. The possible conflicts are: • The left FMS position differs from the right by more than twice the RNP for 5 seconds. • The difference between FMC position and the navigational aid being used (GPS, DME, VOR or Inertial) is greater than 12 NM for 5 seconds.

5. EICAS / ECL Normal Procedures

EICAS (*Engine Indicating and Crew Alerting System*) is the centralised system for monitoring the normal (NM) and non-normal (NNM) status of modern Boeing aircraft. It is a one stop shop for engine indications and crew alerting and in combination with the Electronic Checklist (ECL), provides a human centric set of problem-solving tools for modern aircraft.

This section does not seek to explain the basic mechanics of EICAS or ECL and assumes that you already have the relevant systems and procedural knowledge from the Boeing FCOM, QRH, FCTM and some practical experience. Instead here explained is the philosophy behind EICAS and ECL, providing a consistent framework for all crew to use as a basis for handling EICAS messages, ECL NM and NNM checklists and NNM events in a consistent manner, using the best practice CRM principles of the modern multi crew cockpit. You will also find some handling tips that have come from experience with the aircraft.

You may find some of the procedures and techniques documented here somewhat pedantic and stilted, but they are intended to produce a level playing field in the handling of NNM events across crew of varied language skills, company cultures, experience levels and degrees of fatigue – these procedures become second nature with repetition, and deviations jarringly obvious.

5.1. EICAS/ECL Normal Procedural Summary

This section provides a summary reference list for each paragraph addressing NNM handling procedures for EICAS/ECL. This table will tell you what to do – the detailed sections explain why you're doing it.

Para	Ref	SOP Amplification	Sounds Like …
5.3		When you start a checklist, read the Checklist Title and Condition Statement.	" **Dual Engine Fail/Stall Checklist.** *… Engine speed for both engines is below idle.* "
5.17	QRH CI.1.2	When you've finished a checklist, read the Checklist Title and Completing Statement.	" **Engine Failure Left …** *Checklist Overridden.* "
5.4	QRH CI.1.2	**BEFORE TAKE OFF** & **BEFORE LANDING Checklists** – read back "**Checklist Complete**". Note this is the only time the PF is *required* to do this.	**PM** : " **Before Takeoff …** ***Checklist Complete.*** " **PF** : " *… Checklist Complete.* "
5.5	QRH CI 2.6	• Read all the White Checklist items (*except for the "Inhibited Checklist" items*). • Items missed in the flow can be actioned during the checklist; incomplete or not actioned flows should result in a checklist reset and a repeat of the entire flow. • When responding to an ECL item – "**Read the Glass!**"	
5.6		Any incomplete checklist should remain displayed on the MFD. The MFD may be temporarily used for another purpose – but return it to the checklist when finished.	
5.7		Overriding a checklist is unusual and should make you stop and think.	
5.8		The operation of the Normal Checklist requires **both** pilots to verify the completion of each checklist item.	
5.9		If a NM checklist closed loop item does not close; the checklist Responder states the position as indicated and calls for Override.	
5.10		**EICAS Pre-flight**: Check for Exceedances, Review all messages, leave EICAS clear and check for Status messages.	
5.11		When the Master Warning/Caution switch activates – Call the Failure; and cancel Master Warning/Caution switch to reset for the next one.	
5.12		Keep the lower MFD clear unless it's actively in use.	
5.13		Non-Normal Checklists are to be completed before the Normal Checklists.	
5.14		**EICAS Recall** : PM presses Cancel/Recall switch, calls "**Recall**" and reads messages. PF considers messages and calls "**Cancel EICAS**" (or if no messages … "**Check**"). PM presses Cancel/Recall switch and clears EICAS.	
5.15		**EICAS Review**: At the completion of the NNM, PM reviews (*reads out*) all the messages; PF calls "**Cancel EICAS**".	**PM** : " *(NNM C/List)* **… Checklist Complete.** " **PF** : " **EICAS Review** " **PM** : " *(Reads all displayed EICAS Messages)* " **PF** : " **Cancel EICAS.** "

Para	Ref	SOP Amplification	Sounds Like …
5.16		When the checklist is "**Checklist Complete**" – the standard action is to close the ECL – not click the NORMAL prompt to display the next checklist.	
5.19		Synoptic Displays are there to be used, but EICAS is the primary reference – and Situational Awareness, Aviate, Navigate and Communicate must have priority.	

5.2. NM Checklists are "Done" Lists

Normal Checklists are "Done" lists and as such are called for once the associated normal procedures flows (see FCOM NP's and **Normal Operations Flows**) are done. There should not be a situation where a reference item has to be actioned during a normal checklist. If this occurs a flow is either incomplete or has not been actioned. For the former the crew (Captain) has the option to stop the electronic checklist, complete the omitted respective procedural step, and continue the checklist. In the case of the flow not being actioned – the entire procedural flow should be done, the checklist reset and recommenced from the start.

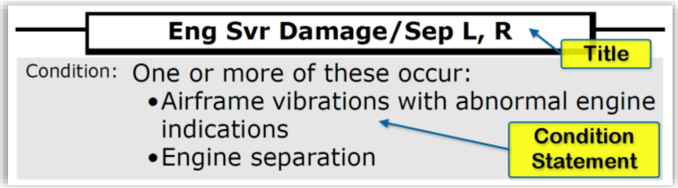
For short term interruptions to the checklist to do other tasks the electronic checklist may be resumed. If the crew (Captain) are uncertain as to where in the checklist the crew are to continue, or if the checklist was stopped for a longer time – the checklist should be reset and recommenced from the start.

All challenge/response normal checklist usage should reflect the overarching glass cockpit philosophy of always calling/using values from the glass, rather than the setting mechanism. This means that selections in relation to the MCP should be called/verified appropriately from the PFD or ND (*while still verifying that the setting on the MCP is correct*). Selections that are on the CDU should be called/verified appropriately from the PFD/ND as well where possible (*such as V1 and V2 during preflight*). See **Read the Glass!**

Where a checklist reference item response is multiple switches (*Passenger Signs, Anti-ice, etc*); if the switch positions are in agreement, the common position is called "**Anti-ice … AUTO**". However, where the switch positions are not all in agreement (such as EAI ON for taxi during cold weather) – individual switch positions are called "**Anti-ice … AUTO / ON / ON**".

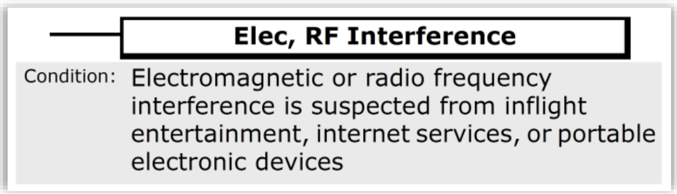
Finally, when a reference items requires a response from multiple crew (**Both** or **All**) – the order of response is the item responder first, and the checklist reader last. For the definitive " **Oxygen Masks … Tested/100% [ALL]** " as read by the First Officer, the accepted correct order for the response is the Captain, 1st Obs, 2nd Obs, and finally the First Officer.

5.3. Read the Title and Condition Statement



Reading the **Title** and **Condition Statement** of all checklists enables the Pilot Flying (PF) & Pilot Monitoring (PM) to confirm that the correct checklist has been displayed. In essence, this reading is a challenge from the PM to the PF to confirm that the correct checklist has been selected – ideally the PF should respond. Note that technically the QRH only requires as much of the condition statement read as confirms the correct checklist selection.

Some NNM's will result in multiple EICAS messages and checklists. EICAS performs only a basic prioritisation of multiple messages and checklists (**EICAS Message Prioritisation**) and it is the responsibility of the Captain to choose the order in which the NNM checklists are actioned. Thus, when the workload is high and the flight path must be positively maintained, reading the title and conditions clearly ensures the PF's requests are being met correctly.



Additionally, some NNM's require the manual selection of an Unannunciated NNM Checklist (**Locating an Unannunciated Checklist**) in which case this confirming step becomes crucial.

By definition, identifying the need for and correctly identifying which Unannunciated Checklist to call for requires memorisation of all Unannunciated Checklist Titles – and the associated Condition Statements.

Note this technique is also used when initiating Checklist Memory Item actions (**Initiating & Actioning Checklist Memory Items**).

5.4. Before Take Off and Before Landing Checklists

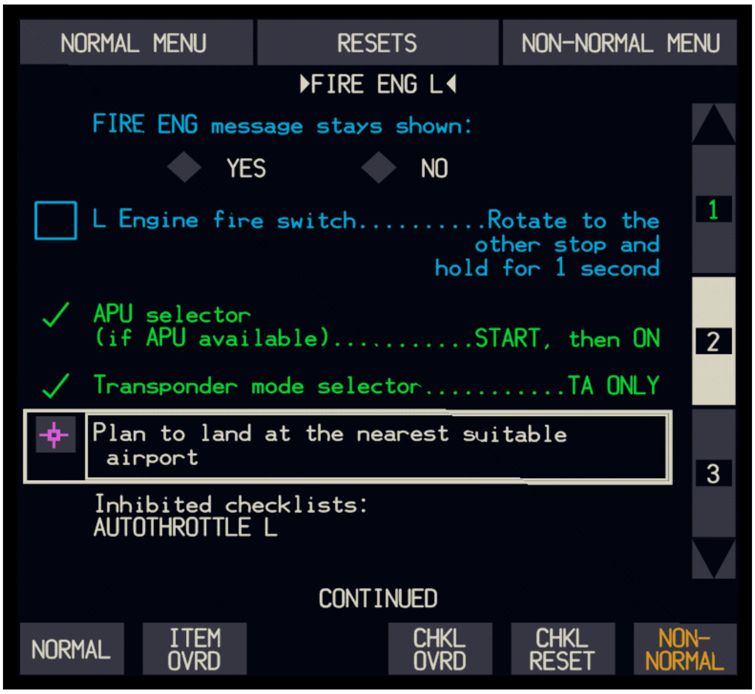
Boeing QRH requires the PF to echo the "**Checklist Complete**" statement after the PM at the completion of these checklists. This implies that the PF will visually confirm that the **correct** checklist was completed – and is complete.

PM : "**Before Takeoff Checklist Complete ...**"
PF : "**.. Checklist Complete.**"

5.5. If it's in White – read it (except ...)

A good rule of thumb is that everything in white on the ECL **must** be read aloud. Neither **completed** (green) nor **not applicable** (cyan/blue) checklist items are read. The white list includes:

- Checklist Titles.
- Conditions Statements.
- Checklist Items.
- Information Notes.
- Yes/No Branches.



As with all good rules – there's an exception.

The item missing from this list is **Inhibited Checklists** (which appear in the **QRH** as "***Do not accomplish the following checklists :***") Reading the Inhibited Checklist list from the ECL is acceptable, but not necessary.

The thinking behind allowing this omission, is that any checklist title that appears in the "**Inhibited Checklists:**" list will be displayed on the EICAS, without the associated checklist icon (❑) and will be evaluated during the subsequent EICAS Review (**EICAS Review**). Thus, reading them during the NNM checklist, then reading them as part of the EICAS Review doubles up, and is not required.

Note the one deviation (*for some airlines*) to this rule is when Checklist Memory Items are actioned from memory. The "**Confirm**" between the reference and action item is not called – see **Initiating & Actioning Checklist Memory Items.** However, when reading the checklist from the ECL – the "**Confirm**" is read out loud. As always – the exception proves the rule.

5.6. Interrupting a Checklist ...

Some checklists incorporate pauses. These can be timed, or they can require waiting for an internal event (*Fuel Jettison Complete*) or external event (*Level at 10,000 ft*). Checklists may also be halted at the direction of the PF/Captain for achieving a more pressing need. Common examples include the Fuel Jettison Checklist, or the Fuel Imbalance Checklist.

If a checklist execution is paused or interrupted for some reason, it should remain open on the lower MFD. It is acceptable to use the lower MFD for another (*higher*) purpose while an ECL checklist is halted (*or in use*). When the lower MFD is no longer required, it should then be returned to the incomplete checklist.

Note that if you have a NNM with a checklist in progress and have managed to work yourself into the situation where the associated EICAS message is not displayed (cancelled); the associated checklist is incomplete; and the ECL is not displayed, the aircraft will figure you've forgotten something and prompt with ❑ **CHKL NON-NORMAL** to highlight your error.

5.7. Overriding a Checklist

The PF's confirmation is required before any checklist item or any checklist is overridden. Note that the overriding of a checklist means any deferred items (**Deferred Checklist Items**) will not be deferred and any Notes (**Checklist Notes**) generated by the checklist will not be lost and instead copied to the ECL Notes page.

Crew new to the aircraft (*but experienced in the simulator*) should note that there are very few instances where a checklist is overridden – the regular exception to this being the ❑ **ENG FAIL** checklist needing to be overridden after an alternative Engine Failure Checklist (❑ **Eng Svr Damage/Sep**, ❑ **Eng Lim/Surge/Stall** or ❑ **FIRE ENG**) has already been completed.

One result of continuous simulator training with repeated cycles of NNM's and the associated NNM checklists is a tendency to override any outstanding checklist that gets in your way. If you find yourself overriding any checklist – stop ask yourself why, stop and ask yourself **are you sure?**

5.8. It Takes Two Pilots to do a Checklist

The Boeing QRH Checklist Instruction section specifies for each of the NM checklists which pilot is to call, read, verify and respond to a checklist item. Perhaps the most important point of this paragraph is that **both pilots are to visually verify that each item is in the needed configuration** irrespective of respondent.

Note that the inclusion of Captain, First Officer, Pilot Flying, Pilot Monitoring, BOTH and ALL beside the NM checklist items is company specific and may not necessarily conform to either area of responsibility or the Boeing QRH CI table Respond column, but are selected to assist in the ease of use of the paper checklist when ECL is unserviceable – with ECL serviceable the items are closed loop.

Checklist	Call	Read	Verify	Respond
PREFLIGHT	Captain	First officer	Both	Area of responsibility
BEFORE START	Captain	First officer	Both	Area of responsibility
BEFORE TAXI	Captain	First officer	Both	Area of responsibility
BEFORE TAKEOFF	Captain	First officer	Both	Pilot flying
AFTER TAKEOFF	Pilot flying	Pilot monitoring	Both	Pilot monitoring
DESCENT	Pilot flying	Pilot monitoring	Both	Pilot flying
APPROACH	Pilot flying	Pilot monitoring	Both	Area of responsibility
LANDING	Pilot flying	Pilot monitoring	Both	Pilot flying
AFTER LANDING	Pilot flying	Pilot monitoring	Both	Pilot monitoring
SHUTDOWN	Captain	First officer	Both	Area of responsibility
SECURE	Captain	First officer	Both	Area of responsibility

Finally, it's worth noting that when a checklist addresses multiple crew ("All") the first reply should come from the other Primary crew member (PF/Captain) followed by 1st Obs, 2nd Obs and then the PM. The only place this occurs is the Pre-Flight Checklist item "**Oxygen** … **Tested 100%** … **All**".

5.9. Abnormal use of the ECL Normal Checklist

There are times when the NM checklist will have a closed loop reference item that cannot complete because of an "unusual" flight configuration. While not limited to this – one example is a go around after which the crew elect to maintain Flap 5 for subsequent vectoring. In this instance the **AFTER TAKEOFF CHECKLIST** "Flaps … Up PM*" checklist reference item will not close because the flaps are not Up. The item will need to be overridden in order for the checklist to complete. The recommended handling for this depends on the responder to the reference item

PM as Checklist Responder

The **AFTER TAKEOFF CHECKLIST** is read by and responded by the PM. In this instance, it is recommended that in the event of a non-closed loop reference item, the PM read the Item as a Challenge to the PF. The PF in turn should monitor the item override and checklist completion, the PF's primary focus is flightpath control.

AFTER TAKEOFF CHECKLIST

Landing gear .... UP PM

Flaps .... UP PM

PM : " **After Takeoff Checklist** "
PM : " **Flaps … Five, Item Override**"
PM : " **After Takeoff Checklist Complete.** "

PF as Checklist Responder

The **Landing Checklist** is read by the PM and responded to by the PF. Some NNM's leave the closed loop **Flaps … ___** item open (*where the ___ values is provided by pilot selection of Flaps into the CDU Approach Reference page*). In this case again the Flaps item will need to be overridden by the PM in order for the checklist to continue/complete.

LANDING CHECKLIST

Cabin .... Ready PF

Speedbrake .... ARMED PF

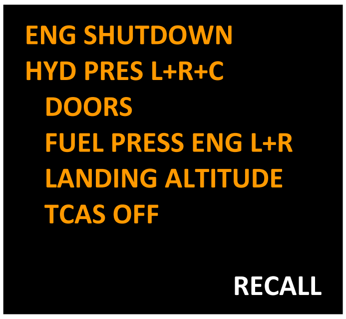
Landing gear .... DOWN PF

Flaps .... ___ PF

PM : " **Landing Checklist** "
PM : " **Flaps …** "
PF : (calling Flaps as displayed on EICAS) "**Twenty. Item Override.** "
PM : " **Checked.** " **After Takeoff Checklist Complete.** "

In all such cases it is crucial that both the PM and the PF verify the desired flap is annunciated on the EICAS display - as opposed to the value indicated in the checklist, of the selection required by the Flap handle.

5.10. EICAS during pre-flight



The Boeing pre-flight setup requires the crew member to:

- Review the EICAS messages
- Review the Status messages
- Look for engine indication exceedances

Coupled with the Tech Log and the external inspection, the following procedure facilitates the Captain's complete knowledge of aircraft status. A good technique is for the Captain to do this on entering the flight deck:

- Display the Secondary Engine Indications on the lower MFD.
- If the EICAS is not clear – press the Cancel/Recall switch until it is.
- Now press the Cancel/Recall switch once (verify "**Recall**" on EICAS) and look for any exceedance indications on both Upper and Lower MFD's.
- Review (*think about*) the EICAS messages (*and any dispatch considerations*), including those on any subsequent pages, pressing the Cancel/Recall switch until the EICAS is clear.
- Press the STAT button and review any Status messages on the lower MFD – and consider their impact on dispatch, as well as Fuel, Hydraulic Fluid, Engine Oil and APU Oil quantities.
- Leave the MFD clear (**Keep the Lower MFD Clear**) if not required for another purpose (*Doors, Fuel, Camera, etc*)

Subsequent EICAS messages during pre-flight should be dealt with as at any other time (**Responding to EICAS Messages**) – called, analysed, (*if necessary*) actioned – and cleared. The practice of keeping all EICAS messages displayed and having them disappear one by one as the engines are started is groovy but not recommended.

5.11. Cancel the Master Warning/Caution Switch

Nothing is more disturbing when things are going wrong that having lights and sirens going off when you're trying to think. The first instinctive action of a crew member should be to cancel the warning. In the case of the Master Warning/Caution light/switch – when it illuminates, press the switch to cancel (**and therefore reset**) the light/switch, and call the failure (**Responding to EICAS Messages**)

Note that the Autopilot Disconnect aural cannot be cancelled by the Master Warning/Caution switch – a (nother) activation of the autopilot disconnect switch is required. The recommended method for autopilot disconnection is pre-announced, double click, silent disconnect.

PF : "**Disconnecting Autopilot**"
PM : "**Checked**"
PF : "**Flight Director**" (Calling ASA change)
PM : "**Checked**"

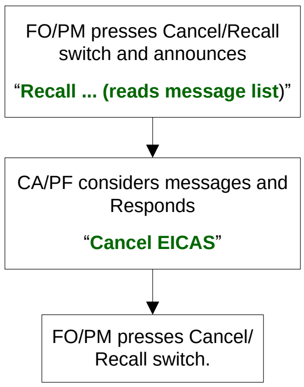
5.12. Keep the Lower MFD Clear

When not in use, the lower MFD should be kept clear. This allows the crew to easily recognise when an engine limit exceedance popup is displayed by EICAS. Note that if a NNM checklist is in play, it should be kept displayed on the lower MFD until complete (**Keep the Lower MFD Clear**).

5.13. Non-Normal before the Normal

NNM checklists are typically to be completed before NM checklists. A useful tip to remember is that when the final EICAS Review (**EICAS Review**) is complete and you tell the PM "**Cancel EICAS**" – consider there and then whether it's appropriate to call for the next NM Checklist (*typically forgotten at this point is the After Take Off Checklist*).

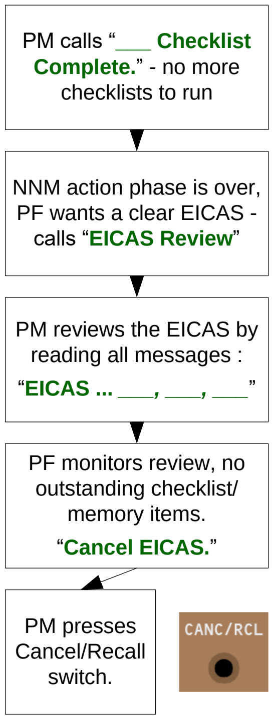
5.14. EICAS Recall



During several of the NM ops flows, the First Officer/PM presses the Cancel/Recall switch and reads the displayed messages to the Captain/PF. It is the Captain/PF's job at this point to consider the message list and the stage of flight being contemplated. This primary reason for the EICAS Recall is to build crew situational awareness and encourage thought about the aircraft technical status into the conscious decision-making process.

Note the Captain/PF would only respond "**Cancel EICAS**" if the messages involved were expected and no NNM checklists were outstanding. As always, multiple pages of messages may need to be reviewed. If there are no EICAS messages as the result of a Recall, Captain/PF should respond with simply "**Check.**"

5.15. EICAS Review



An EICAS Review is different. At the completion of all (*or each if necessary, see below)* outstanding NNM checklists, the PF should call for an "**EICAS Review**". The intent of this procedure is to allow the PM to clear the EICAS without clearing any messages the PF has not considered/dealt with – whether or not those messages have checklists associated. A Review also allows the clearing of EICAS without having to read the messages associated with previous failures already dealt with.

So – PF calls for "**EICAS Review**". PM then reads the currently displayed messages from the EICAS. PF considers the messages, ensuring there are no outstanding checklists and that an appreciation of the technical status of the aircraft and the impact on the rest of the flight has been reached. PF then responds "**Cancel EICAS**". Note that it's possible for a NNM checklist to be in the queue without an icon appearing on EICAS – the **NON-NORMAL** prompt in the bottom RHS corner of the ECL will indicate if more NNM checklists are still in the queue.

It should be noted that this is **not** an **EICAS Recall**. A complete EICAS Recall is not procedurally required at this point. Any messages not currently displayed on EICAS at the end of a NNM checklist do not need to be recalled and re-read at this point. That's not to say that the PF can't call for an "**EICAS Recall**" at any time if desired for situational awareness.

Calling for EICAS Review during Multiple Failures

When a significant failure is in progress that involves multiple EICAS messages and associated Checklist/Memory Items, or if some change in the Aircraft status occurs to alter the EICAS message list – the PF can call for an "**EICAS Review**" at the end of the completion of any NNM Checklist/Memory Items to assist in deciding what the next action should be. Normally however, the PF uses the EICAS and checklist icons to decide on the next Checklist/Memory Items to be actioned, without the need for an EICAS Review.

5.16. Checking the next checklist

When a NM checklist is "**___ Checklist Complete**" the EFIS **CHKL** button should be pressed and the ECL closed. There is no need to click on the ECL NORMAL prompt to display the next checklist, nor should the **CHKL** button be pressed again to check if the next NM checklist is there, or to ensure the next checklist will not be forgotten. This bad habit also goes against the recommended technique of keeping the lower MFD clear unless it's being used for a real purpose.

5.17. When a checklist is over …

All checklists should finish with the PM reading in full "*Checklist Title …* **Checklist Complete.**", "*Checklist Title …* **Checklist Complete Except For Deferred Items.**", or "*Checklist Title …* **Checklist Overridden.**" At this point in the NNM event handling cycle (**EICAS/ECL NNM Checklist Cycle**), the PF is required to initiate the next step in the process – whether this is calling for the next NNM checklist, an EICAS Review (**EICAS Review**) or a NM checklist. These phrases should be a prompt to the PF that input is required once again to direct the flow of problem solving.

5.18. NM ECL Checklist and Variable Open Loop Items

The NM checklists include some items that are open loop and variable. These include items such as **Autobrakes** and **Anti Ice**. The checklist responder is required to verify and call the current state of the relevant system/selector, etc. In some cases this covers multiple systems – such as Anti Ice or Passenger Signs.

BEFORE TAXI CHECKLIST		
Anti-ice	___	C
Recall	Checked	C
Autobrake	RTO	C
Flight Controls	Checked	C
Ground equipment	Clear	BOTH

When EAI has been selected ON after engine start, the proper response to the Before Taxi Checklist's "**ANTI ICE …**" is "**AUTO … ON …ON**" indicating the status of **all** anti-ice – Wing, Engine, Engine. When all switches are in AUTO the response is simply "**AUTO**".

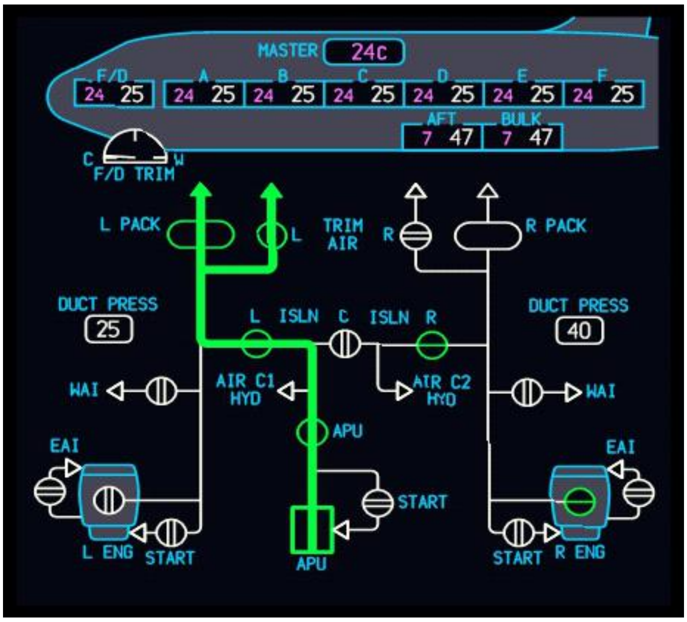
In the Before Start Checklist, the Passengers Signs checklist item is currently open loop, but scripted as "**AUTO**". However, at this point the **NO ELECTRONICS** signs are **AUTO** and the **SEAT BELTS** selector is **ON**. The correct response is "**AUTO … ON**"

5.19. Synoptic Display Usage

Synoptics displays are always available for crew use. This includes during NNM events and while NNM checklists are in progress. However, any use of synoptics should not interfere with the requirement to focus on task completion – don't let your curiosity about a synoptic display interfere with completing a NNM checklist. The need to see the synoptic should be genuine – not curiosity.

The synoptics can provide an important visual snapshot of the status of the various systems of the aircraft, particularly at the completion of the NNM checklist after a NNM event. For example, sometimes the Flight Controls Synoptic page can provide a visual representation of a series of failed spoilers with greater clarity than a generic ECL Notes statement.

Note that it is acceptable to use a Synoptic display on the left or right MFD's, for example during ECL use. However good airmanship dictates that the display of a synoptic should not impede the PF's navigational situation awareness, nor the PM's ability to monitor the PF.



Recent incidents have highlighted the usefulness of the Synoptics to provide flight crew with a non-specific snapshot of the damage done to an aircraft (*or more correctly, what's left working on the aircraft*) after severe NNM's such as significant damage to electrical sub-systems or significant engine damage events.

Finally, note that Boeing cautions against Synoptics being used to diagnose problems and that in some specific instances synoptic displays can be misleading as to the true state of a system. EICAS is always the primary source for NNM handling.

6. EICAS/ECL – Non Normal Procedures

EICAS Non-Normal procedures are built based on documentation provided in the QRH. The primary difference is that while Normal ECL is a "Done List" actioned after normal operations flow – Non-Normal ECL are "Do Lists", including the requirement to action memory items prior to following up with the associated NNM checklist(s).

6.1. EICAS/ECL Non Normal Procedural Summary

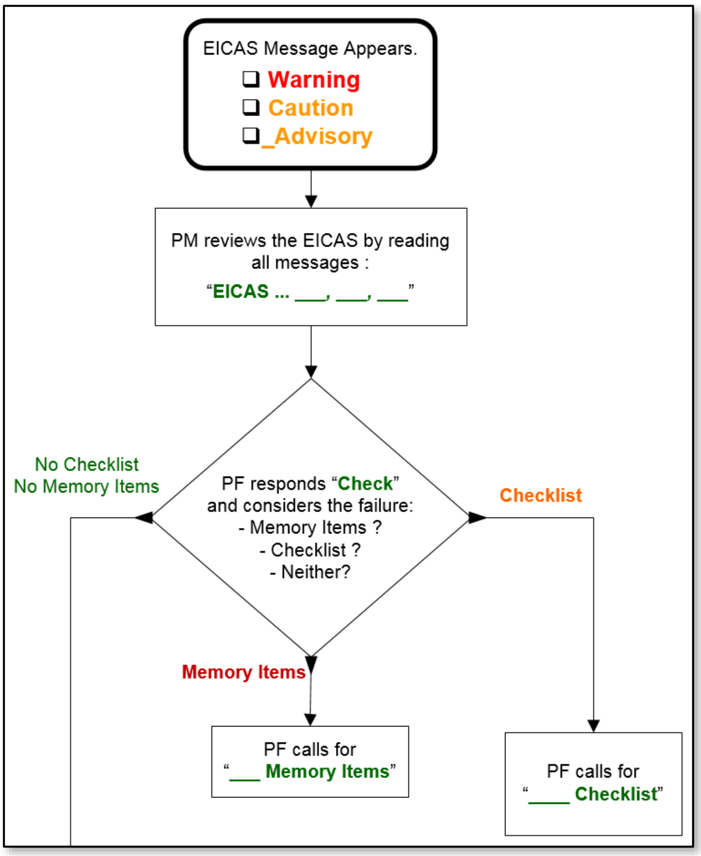
This section provides a summary reference list for each paragraph addressing NNM handling procedures for EICA/ECL. This table will tell you what to do – the detailed sections explain why you're doing it.

Para	Ref	SOP Amplification	Sounds Like …
6.2		When a NNM event occurs, PM will call "**EICAS**" and identify the problem (read the message).	"**EICAS … Thrust Asymmetry Compensation**"
6.3	QRH CI.2.5	Checklist Memory Items should only be called for once Flight Path and Navigation are stabilised, and will remain so.	
6.4	QRH CI.2.5	Checklists should only be called for once Flight Path and Navigation are stabilised, Memory Items are complete and the aircraft is not in a Critical Stage of Flight.	
6.5	QRH CI 2.5	Checklist items that are not normally Memory Items may be called for from memory by the Captain/PF when doing so is deemed both non-hazardous and desirable, or if reference to a checklist is not available.	
6.6 6.10	FCOM 15.20.1	EICAS prioritises **Warning**/Caution/_Advisory messages and checklists, but not within these categories. It is within the PF's authority to select the order of Checklist/Memory Item action, guided by EICAS & airmanship.	
6.8		At the end of each/all NNM Checklist(s) – the PF has the options of calling for either an "**EICAS Review**" or an "**EICAS Recall**" – or the next outstanding NNM checklist.	
6.11		Certain Engine Controls that require confirmation can be guarded by the PF if the control is in the PM's area of responsibility.	
6.12		Yes/No decision branches in the checklist require the agreement of both crew and should not be pre-empted by PM.	**PM** : "**Fuel to remain must be changed – YES or NO?**" **PF** : "**Hmmm … NO**" **PM** : "**I agree "… (clicks NO) … "NO**"
6.13	QRH CI 2.5	Checklist actions that require confirmation are : • Auto Throttle Arm Switches, Thrust Levers, Fuel Control Switches, Engine Fire Switches, APU Fire Switch, Cargo Fire Arm Switch, Generator Drive Disconnect Switches. • This excludes the Fuel Control Switches during Dual Engine Fail/Stall Memory Items; and Checklist/Memory Action Items on the Ground.	
6.14	QRH CI 2.5	Checklist items should be read aloud in entirety, the Item Action performed, the Action re-stated and the checklist reference item clicked off (where necessary).	
6.9		Keep the EICAS Clear. Once a NNM is over – Review (**EICAS Review**) and Cancel the EICAS.	
6.16		Initiating and actioning Checklist Memory Items is a facsimile of initiating and actioning a NNM checklist.	**PM** : " **EICAS … Fire Engine Left** " **PF** : " **Fire Engine Left Memory Items** "
6.17		Checklist notes are collected through the completion of NNM checklists – unless a checklist is Overridden (**Overriding a Checklist**) rather than completed. Notes are used to review the implication of a failure long after the NNM checklists have been completed. See the detailed section for the dispatch with TAC inoperative example.	
6.15		Crew should consider Unannunciated Checklist titles and condition statements as memory items. PF could consider prefacing a call for such a checklist with "**Unannunciated**" as an aid to the PM.	
6.18	QRH CI.2.3	The checklist statement "**Plan To Land At The Nearest Suitable Airport**" does <u>**not**</u> require you to begin preparing for landing during the NNM checklist. By implication, this statement is an indication of the urgency of the NNM situation. Protect your current task – finish the checklist.	
6.20		Entering ECL NNM adjusted approach speeds needs to be done carefully. Select the Flap Line first, then modify the indicated speed based on the ECL Note. Consider confirming the result with the PF.	
6.22		When a Checklist is **COMPLETE EXCEPT FOR DEFERRED ITEMS**, there is no requirement to – but it is considered acceptable to review these items before continuing through the NNM checklist cycle.	

Para	Ref	SOP Amplification	Sounds Like …
6.19		The quickest way to locate an Unannunciated Checklist is through the ECL Non-Normal Menu – UNANNUNCIATED CHECKLISTS … prompt.	
6.25		When multiple NNM checklists are queued, they are handled in a cycle. The loopback process commences at "**Checklist Complete**" with the PM prompting (*if necessary*) "**More NNM Checklists**".	
6.26		When a NNM checklist is complete and another exists – PM can click on the NON-NORMAL to display either the next NNM checklist, or the NNM checklist queue.	

6.2. Responding to EICAS Messages

From the point of view of EICAS, a NNM event starts in one of two ways. Either EICAS detects a problem and generates an associated **WARNING**/**CAUTION**/_**ADVISORY** or abnormal engine indication, or the problem is detected by the crew and Unannunciated Checklist/Memory Items are called for.



The technique for handling EICAS messages and possible associated actions is as follows.

- PM (or PF) sees the message and announces it clearly "**EICAS – (*Message*)**"
- PF calls "**Check – (*Message*) Checklist/Memory Items**".
- If the EICAS message has a checklist Icon (❑), the PF calls for either the "***(Message)* Checklist**" – or if that checklist includes Memory Items, then PF first calls for the relevant memory items "***(Message)* Memory Items**".

Note that the radio should remain the responsibility of the PM. The exchange of responsibilities is not encouraged by Boeing as it divides the crew, especially during a critical time such as a NNM Checklist/Memory Items. Flight path remains the primary responsibility of the PF; Communication is to remain the responsibility of the PM. The PM is strongly encouraged not to make radio calls during Checklist Memory Items.

6.3. When to do Memory Items

Checklist Memory Items are those items at the beginning of a checklist that must be committed to memory and actioned from memory as a response to a NNM event. Boeing has two statements regarding when to call for NNM Checklists.

"***Non-normal checklist use commences when the airplane flight path and configuration are correctly established***"

"***Flight path control must never be compromised***"

By implication, Memory Items should be called for and completed expeditiously. However it is suggested that Memory Items should not be called for until:

- The **Flight Path** is under control.
- It is established that this control will be maintained whilst the Memory Items are being carried out – that is, the PF is able to handle other tasks such as:

  - Monitoring an engine shutdown.
  - Manipulate the MCP.

It is strongly recommended the Autopilot (AP) be engaged prior to calling for Memory Items.

6.4. When to do NNM Checklists

A NNM checklist should only be called for when:

- The **Flight Path** is under control.
- The **Navigation** is under control.
- The aircraft is not at a **Critical Stage** of Flight.
- All Checklist Memory Items are complete.

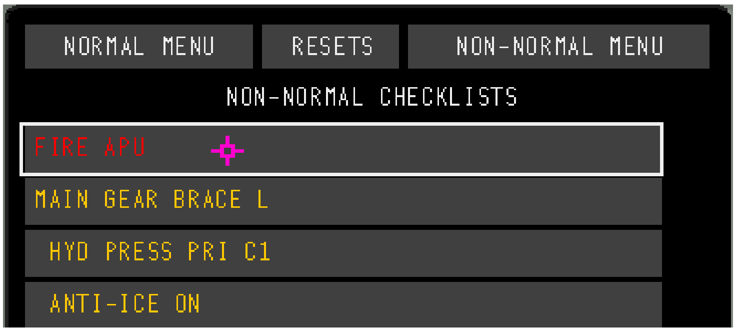
Prior to commencing a lengthy (or series of) NNM checklists, the PF could give consideration to a mini-plan that will take care of the Navigation and Communication aspects of the aircraft. Heading towards an airport, taking up a hold, advising ATC – all could be considered appropriate actions prior to the commencement of NNM Checklists.

6.5. Checklist Items by Memory

The PF may direct that a checklist action be completed from memory when the action is not a memory item. PF should only do so if "***no hazard is created by such an action, or if the situation does not allow reference to the checklist.***"

In practice this option is seldom exercised by the PF, for obvious reasons. Generally, it is used to justify continuing the Engine Limit/Surge Stall Checklist from memory to shut down/secure a misbehaving engine; or to pre-empt damage in the event of an engine oil loss. Note this paragraph is not an encouragement to use checklist items from memory in either of these situations.

6.6. Prioritisation of NNM Checklists



After an EICAS event that results in multiple NNM checklists, the PM & PF will be confronted with an ECL that provides a list of NNM checklists to be completed. Note that the ECL prioritises these checklists at the same basic level of **WARNING**/**CAUTION**/_**ADVISORY** that EICAS does (**EICAS Message Prioritisation**) and it is up to the Captain/PF to determine which checklist is done next.

6.7. CHKL After Takeoff … NOT

It's pretty automatic to press the EFIS Control Panel **CHKL** button once the flaps are selected up after takeoff. This is basic Boeing standard flow and like all the other times the First Officer/PM presses the CHKL button after an action – it's a layer of defence against forgetting the checklist.

But this action is not recommended anytime there is a NNM checklist in the queue from an event that occurred during the takeoff. Selecting the **CHKL** button in this case displays the NNM checklist and pre-empts the decision making of the PF; and in some instances completes the checklist that hasn't been called for. So, for a takeoff with an obvious (*see below*) NNM – don't press the button until the PF has called for the NNM checklist.

Note also that there are occasions where there will no longer be a checklist icon showing on the EICAS – but the checklist will still be there and should not be called for. On such classic example is a PACKS OFF takeoff, where the PM presses **CHKL** to show the After Takeoff Checklist – but gets one (or both of) the PACK checklist(s) because then Packs haven't quite made it on yet.

6.8. NNM Checklists Complete ... EICAS Recall vs Review

It is not necessary to perform a Recall of the EICAS when NNM checklists are complete. At this point the PF will normally want to clear the EICAS to move on with the management stage of the NNM. Unless the PF wants a complete review of all NNM failures that have occurred since engine start – all that is required is an **EICAS Review** to facilitate clearing the remaining (checklist free) EICAS messages.

6.9. Keep the EICAS Clear

Once a NNM has been dealt with, Review the EICAS (**EICAS Review**) and Cancel. Keeping the EICAS clear enables further messages associated with subsequent systems failures to be noticed quickly and actioned by the crew.

Do not cancel messages without an EICAS Review.

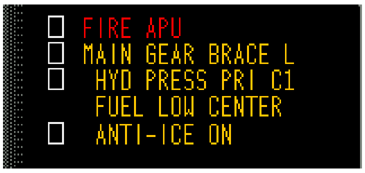
Note that you cannot cancel a **WARNING** message on the EICAS – these remain until the displayed condition no longer exists.

6.10. EICAS Message Prioritisation

EICAS alert messages result from a non-normal condition; a system fault or failure; or an incorrect configuration for the phase of flight. Significant failures or failures in combination can result in multiple EICAS messages of varying levels, as well as multiple NNM checklists. The ECL queues multiple NNM checklists (**Prioritisation of NNM Checklists**) pending checklist completion.

EICAS prioritises multiple messages on the basis of **WARNING**/**CAUTION**/**_ADVISORY** and that is all. It is the responsibility of the Captain/PF to select which message is the next to be actioned. This decision process should follow the following priority list:

- Checklist Memory Items
- **WARNINGS** (and ❑ **WARNINGS**)
- ❑ Checklists with Memory Items
- ❑ **CAUTIONS** with a Checklist
- ❑ **_ADVISORIES** with a Checklist



However, it is well within the authority of the Captain/PF to decide which message is to be dealt with first. Consider some of the following EICAS Messages/Checklists/Memory Items and the possible prioritisation in comparison to others of a similar level of EICAS priority.

- Memory Items for **CABIN ALTITUDE** (*Oxygen is good for you*).
- Memory Items for **STABILIZER** (*Control of the aircraft is important too*).
- Memory Items for ❑ **Eng Svr Damage/Sep**.
- Checklists for ❑ **CABIN ALTITUDE** vs ❑ **STABILIZER** vs ❑ **Eng Svr Damage/Sep** (*checklists with Memory Items*)
- Checklists for ❑ **FWD CARGO DOOR** and ❑ **SLATS DRIVE** (*both cautions*).
- Checklist for _❑ **THRUST ASYM COMP** (*Advisory*) over ❑ **ENG FAIL** (*Caution, to be overridden after Engine Damage*)

By implication, the ability of the Captain/PF to prioritise between checklists of similar levels of EICAS prioritisation is enabled by familiarity with the messages and checklists contained within the QRH. Keep studying.

6.11. Guarding Critical Controls

Some airlines mandate guarding critical engine controls when actioned during NNM checklist/memory items by the PM. Good airmanship suggests that when critical engine controls are being confirmed and actioned - the PF can guard the functional control. Specifically, this should include the following checklist actions.

- **FUEL CONTROL Switch**....... **CUTOFF**
- **Engine Fire Switch**............. **Pull**

Guarding is only relevant when the control is actioned by the PM. While the PF must confirm with the PM the correct identification of the A/T ARM switch and Thrust Lever prior to actioning a recall or checklist, it is not considered necessary for the PM to guard the relevant functional control in this case.

Note that the PF should not guard the control in such a way as to permit the accidental selection of the control by either pilot – the intent is to preclude the control be actioned – not facilitating the accidental selection of the control by the PF.

When guarding a control (*such as the Fuel Control Switch*), **the PF should not grip the control**, as if about to action it; rather PF should prevent the control from being actioned – even by the PF. An example of this methodology in action is resting a clenched fist on the Engine Fire Switch (*so that can't be pulled*) as well as up against the fuel control switch, so that it cannot be selected to Cutoff.

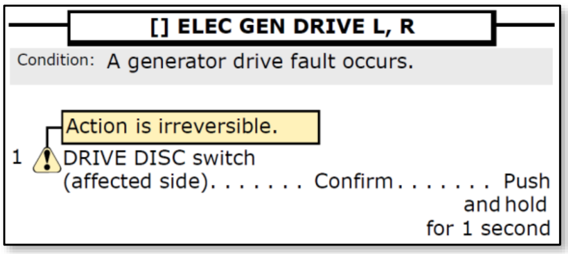
6.12. Yes / No Decision Branches

Occasionally the ECL will require the answer to a Yes/No question. **These questions require the input/confirmation of the PF.** PM should avoid pre-empting the PF's decision by highlighting either of the answers in the checklist (*such as is shown here*).

PM : " **Fuel to remain must be changed – YES or NO?** " **PF** : " **Hmmm … NO** " **PM** : " **I agree …** " (*clicks* ◆ NO) "**… NO** "	**PM** : " **Flap position between 5 and 20 – YES or NO?**" **PF** : " **Uuhh … No.**" (or more typically) "**Uh … Check**" … … … **PM** : " **Capt … Flap position between 5 and 20 – YES or NO?** " **PF** : "**Oh … YES.**" **PM** : "**I agree …**" (*clicks* ◆ YES) "**…YES.**"

6.13. Actions Requiring Confirmation

Good CRM dictates that the PF monitors the actioning of all checklist items to ensure it is being done correctly. That said, the plane must be flown and navigated, communications dealt with and situational awareness maintained as well. It is not required that the PM confirm with the PF the correct actioning of all checklist items. However, the following actions **must** be confirmed by both crew before the action is completed by either pilot.



[] ELEC GEN DRIVE L, R
Condition: A generator drive fault occurs.
Action is irreversible.
1 DRIVE DISC switch (affected side). . . . . . . Confirm . . . . Push and hold for 1 second

- Auto Throttle (A/T) Arm Switch.
- Thrust Lever.
- Fuel Control switch.
- Engine Fire switch.
- APU Fire switch.
- Cargo Fire Arm switch (guarded).
- Generator Drive Disconnect switch (guarded).

The exceptions to this requirement include:

- The Dual Engine Fail/Stall Checklist Memory Items where the PM is expected to cycle both Fuel Control Switches without confirmation.
- Any Checklist/Memory Item actioned on the ground.

Some checklist items include the statement **Action is irreversible**. Good airmanship dictates the PM should seek the confirmation of the PF prior to such actions, whether the checklist prompts for this confirmation or not.

Other controls often considered for confirmation are guarded switches. However, when you consider that this would include the RAT deployment during a Dual Engine Fail/Stall, the Passenger Oxygen switch during Cabin Altitude Memory Items, and other guarded but reversible switches such as the GPWS FLAP OVERRIDE – it becomes clear why guarded switches are not part of Boeing's list. That said, if you're about to action a guarded switch, stop, think and be sure (*doesn't that apply to all switching?*)

6.14. Performing Checklist Actions

AFT OUTFLOW VALVE MANUAL SWITCH...........................OPEN
Position outflow valve fully open to depressurize the airplane.

Checklist actions are performed in a deliberate, unhurried manner. While the PF's agreement is not required for most checklist actions (Actions Requiring Confirmation) the actions should be performed with a verbalisation that allows the PF to fly the aircraft, navigate and follow the checklist. Checklist actions are performed generically in much the same way that a Checklist Memory item is actioned.

Recall/Checklist Actions & Flow	Verbalisation and Control Actions.
PM reads each Reference line and the **Response** and any **Amplifying Information.**	"**AFT OUTFLOW VALVE MANUAL SWITCH … OPEN Position outflow valve fully open to depressurize the airplane.**"
PM Performs the **Action**.	Positions the Outflow Valve to full Open.
PM Re-States the **Action**.	"**Open.**"
PM Clicks Off the checklist item if required.	

6.15. Unannunciated Checklist Titles/Conditions are Memory Items

Some failures require the PF to call for an Unannunciated Checklist from memory – some of them with Memory Items. Knowing which checklist to call for can be a challenge. **Crew are well advised to consider the Titles and Condition Statements of Unannunciated Checklists as Memory Items.** It can be quite difficult to call for a checklist when you don't know which checklist is appropriate for the fault you've detected – or you don't know the correct title of the checklist. For example – the left engine does not respond to thrust lever movement – which Checklist/Memory Items? In this situation, PF could, by recall and using the correct wording, call for the "**Engine Limit/Surge/Stall Left Memory Items.**"

When it comes to calling for the checklist, the PF could consider prefacing a call for an Unannunciated Checklist with "**Unannunciated**". In times of adrenalin and stress – a PM might find it easier locating the "**Unannunciated Engine Limit/Surge/Stall Left Checklist.**" Worth a read is Locating an Unannunciated Checklist.

6.16. Initiating & Actioning Checklist Memory Items

Some checklists begin with Items that are to be completed from memory. As such the technique employed when calling for, actioning and completing Checklist Memory Items follows the same methodology as a non-normal checklist (**Performing Checklist Actions**)

With NNM checklists - PF calls for a NNM checklist, PM finds the checklist in the ECL and reads the checklist title, then reads the checklist action items, and the actions themselves are completed by the pilot who has the area of responsibility over the control, accounting for confirmation (**Actions Requiring Confirmation**) and control guarding (**Guarding Critical Controls**). Once the action is complete, the actioning pilot restates the action. When the checklist is complete, PM will re-state the checklist title, and "**Checklist Complete**".

Memory Items are done in much the same way. PF calls for the ___ Checklist Memory Items, PM re-states (agrees), PM reads the items (from memory), they're actioned (area of responsibility/confirmation/guarding) and when complete, the PM announces "**____ Memory Items Complete.**"

NNM Event Stage	PF/PM Calls & Actions	Details & Background
❑ **FIRE ENG L** (*someone reset the Master Warning/Caution switch*)	**PM : "EICAS – Fire Engine Left"**	The PM (ideally) calls the failure from EICAS.
	PF : "Check" … "Fire Engine Left Memory Items"	PF responds, verifies, and selects the next action to be taken.
Recall/Checklist reads : A/T ARM switch...................*Confirm* OFF *(PF Area of responsibility)*	**PM : "Fire Engine Left Memory Items"**	PM re-states the Memory Checklist to be actioned, (agreement) then begins the memory actions.
	PM : "Left AUTOTHROTTLE ARM switch … Confirm[2] … OFF"	PM calls the Checklist Items from memory.
	PF : "Confirm ?"	PF touches the A/T Arm Switch and seeks confirmation from the PM.
	PM : "Confirmed"	PM confirms the correct control selection.
	PF : "Off"	PF Selects left A/T Arm switch to Off and restates the action ("**Off**") now completed.
Recall/Checklist reads : Thrust Lever .... *Confirm*… Idle *(PF Area of responsibility)*	**PM : "Left Thrust Lever … Confirm[2] …Idle"**	PM calls the next Checklist Memory.
	PF : "Confirm ?"	PF identifies (touches) the control and seeks confirmation.
	PM : "Confirmed"	PM confirms the correct control selection.
	PF : "Idle"	PF actions the Memory Item and re-states the completing Action.
Recall/Checklist reads : FUEL CONTROL switch. *Confirm*… CUTOFF *(PM Area of responsibility)*	**PM : "Left Fuel Control Switch … Confirm[2] … Cutoff"**	This control is in the PM's area of responsibility. PM calls the Checklist Items from memory.
	PM : "Confirm ?"	PM identifies the control seeks confirmation.
	PF : "Confirmed"	PF can guard the functional engine control and confirm the correct control selection by the PM.
	PM : "Cutoff"	PF actions the Memory Item and re-states the completing Action.
… And so on … until …		
Checklist Memory Items Complete.	**PM : "Fire Engine Left … Memory Items Complete"**	The crew now moves on to an **EICAS Review** for the next step: • Another Checklist with Memory Items; or • The ❑ **FIRE ENG L** NNM Checklist.

- It doesn't matter who resets the Master Warning/Caution switch, nor does this require confirmation. It should be reset as soon as it is noticed (**Cancel the Master Warning/Caution Switch**) so the system is ready for the next activation.
- Although it looks here like the call "**Fire Engine Left Memory Items**" is repeated by both PF and PM, in fact this procedural terminology is based on the use of NNM checklists (see **Performing Checklist Actions**) and is procedurally correct as well as being the PM's concurrence with the PF's decision.
- When the PF/PM confirms that the control referenced verbally by the PM/PF has been identified (touched) correctly – this should include checking the EICAS to ensure that the affected control has been referenced. **There's no point confirming that the PM has his/her hand on the Right Fuel Control Switch, when it was the Left Engine that was damaged and needs to be shut down.**

[2] Note that this the "… Confirm " in the middle of the checklist reference item is omitted by some airlines to reduce verbal clutter during memory items – but only when running the Checklist Memory Items. When running the checklist from ECL/QRH – it is not omitted - see **If it's in White – read it (except …)**

6.17. Checklist Notes

Many checklists incorporate notes to crew. These notes have the potential to affect the subsequent operation of the aircraft and are collected by the ECL for later reference using the NOTES prompt at the bottom of the MFD ECL display.

The philosophy here anticipates a non-normal event occurring significantly prior to approach and landing, or during the Relief Crew operation. While preparing for the approach briefing, PF will consult the ECL Notes to assess the impact of the flight's NNM's on the approach and landing. Subsequent reference is often relevant during the Arrival Briefing.

Note however that in the event a checklist with notes is overridden (**Overriding a Checklist**) – the associated notes will not be collected by the ECL. It should also be noted that the action of RESETS ... RESET NON NORMALS clears any accumulated notes in the ECL.

An example of this is dispatch with TAC inoperative. After pushback, the EICAS ❑ **THRUST ASYM COMP** message will display, with the associated checklist icon. The checklist specifies resetting the TAC switch, which is of course switched off in accordance with the MEL. The crew elects to override the checklist – and so the note regarding manual control inputs for asymmetric thrust conditions will not appear in the ECL notes for later referral. Oops.

Running the checklist to completion however (*Item Overriding the TAC Switch is typically the logical action*) retains the Note in the ECL for later awareness.

A refresh of the Notes (along with an **EICAS Recall**) should be completed as part of your Preparation/Arrival Brief – as is stipulated in the Descent Checklist.

6.18. Plan to land at the nearest suitable airport

When this statement appears in the checklist, crew are often tempted into beginning the management phase of a NNM – seeking the information necessary to choose a suitable airport for an immediate landing - weather, NOTAMS, runway in use, approach, etc. That is not the intent of this checklist statement. The "**Land ASAP**" checklist statement is establishing the need for a "landing at the nearest suitable airport" – it is not intending you to choose it during the checklist. At this point your immediate task is the completion of the non-normal checklist (*and the next*) – protect this task and finish it.

PF should acknowledge the statement, *perhaps* state a brief intention "**Ok, we'll look at a return to Sydney shortly.**" and the checklist should go on. Implicitly, this statement is an indication of the urgency of the NNM event.

Some situations require landing at the nearest suitable airport. They include, but are not limited to:

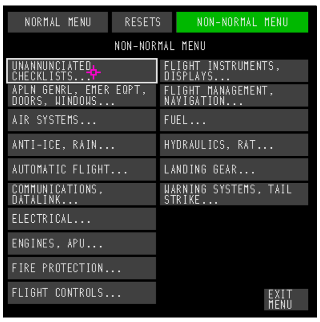
- The Non-Normal checklist says so "**Plan to land at the nearest suitable airport.**"
- Cabin Smoke or Fire, (*technically uncontained Fire, or un-determined smoke source*).
- 1x AC power source remaining (*Engine Generator OR APU Generator OR Backup Electrical System*).
- Any other situation determined by the crew to present a significant adverse effect on safety if flight is continued.
- For persistent smoke, or fire that cannot be positively confirmed to be extinguished, the **earliest possible descent, landing and passenger evacuation** should be accomplished.

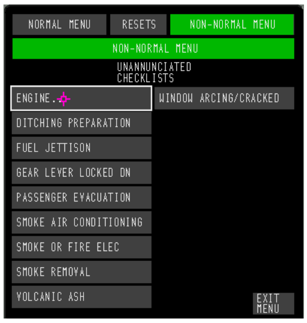
Note that the two backup generators that constitute Backup Electrical System are considered a single power source. The RAT is **not** considered a source for this determination.

6.19. Locating an Unannunciated Checklist

There are two ways of locating an Unannunciated Checklist in the ECL.

The easiest way is to use the UNANNUNCIATED CHECKLISTS... prompt, which is the focus of the cursor when you open the NON-NORMAL MENU of the ECL (*there's a hint*). At this point the available Unannunciated Checklists are either grouped under the ENGINE… prompt, which is the focus of the ECL cursor (*another hint*) or directly available. In essence – open the ECL NNM Checklist Menu, click, click and you're immediately looking at a complete list of the Unannunciated engine failure checklists. You'd almost think it was designed that way …





An alternative method is to look within the system (such as FUEL... for the Fuel Jettison Checklist). This requires several more clicks and is not the recommended method.

"***The quickest way to an Unannunciated Checklist is the* UNANNUNCIATED CHECKLISTS ... *prompt*.**"

6.20. NNM Approach Speeds

> **Note:** Use flaps 20 and VREF 30 + 20 for landing. Higher approach speeds improve airplane maneuvering characteristics.

One common error made during NNM ops is the entering of a modified Flap and V_{REF} setting into the FMC as the result of a NNM. The clue here to realise you are being given two separate pieces of information – the Flap Setting to enter into the FMS, and the Reference Speed used for the approach. In the example given here – **Flaps 20** and a reference speed of **V_{REF} 30+20**.

- Select the line appropriate to the **Flap Setting**. (LSK 1R : **20º / 156KT**)
- CLR the speed in the scratchpad and replace with a calculated replacement – which in this case is VREF 30 (138 knots) + 20 = 158 knots.
- Line Select **20/158** the scratchpad into the FLAP/SPEED line (LSK 4R).

Note that strictly speaking it's entirely valid just to type this required value into the scratchpad yourself (20/158) and line select into 4R – but best practices with the FMC is generally to line select (especially Waypoints) wherever possible.

Note that the "20" in "20/158" sets the "**Flaps ….**" in the Landing Checklist.

PM should consider cross-checking the setting with the PF, although PF should check this value separately as part of preparing for the approach.

It's not a bad technique to pause the NNM checklist and enter this speed into the FMC when the Note appears in the checklist. Beware however of significant changes subsequent to setting VREF, owing to Fuel Jettison etc. If you don't set the VREF in the checklist – you'll pick it up when you review the ECL Notes as part of your Preparation/Arrival Briefing (*won't you …*)

Another good technique any time you are selecting an approach speed is to cross check your weight with the Maximum Landing Weight of the aircraft. **Anytime the Flap 30 Reference Speed is at/above 148 Knots – check!**

6.21. Failure Assessment

For simple failures that result in a single or small selection of EICAS messages, the failure will be called by the PM (*read the EICAS*) and the PF will review and call for the appropriate Checklist/Memory Items.

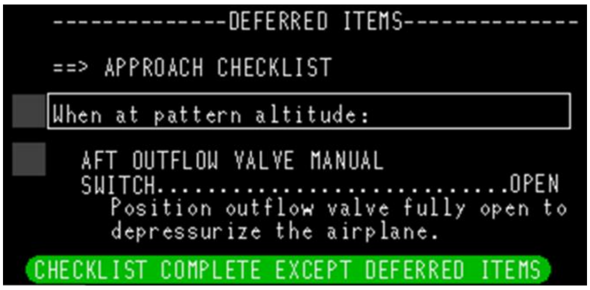
During critical phases of flight such as takeoff, the PM may choose not to call the EICAS message(s) until PF has achieved flight stabilisation and navigation, along with a "safe" height (*such as 400 ft AGL*). Once ready, the PF can prompt "**Identify the Failure**" to prompt the PM to commence the analysis of the malfunction.

For more complex failures, such as those involving multiple system failures or most of the malfunctions involving an engine problem – again the PF may call for the PM to "**Identify the Failure**" once each cycle of the ECL NNM Checklist is complete.

In both cases, PM will commence any malfunction assessment by reviewing the EICAS messages generated. If there are a significant number of messages, this review can be restricted to the more relevant Warnings/Cautions as appropriate.

For Engine Malfunctions, the procedures documented in **Engine Failure Analysis** provide a clear, simple diagnosis of engine malfunctions that lead to one of the 5 applicable engine fire/failure checklists.

6.22. Deferred Checklist Items



Some checklists gather together items which must be completed as part of the Descent, Approach or Landing Checklists. These items will be collected together at the bottom of the NNM checklist and will appear later on as part of the relevant NM checklist.

Note that it is permissible for the PF/PM to review these items once CHECKLIST COMPLETE EXCEPT FOR DEFERRED ITEMS stage is reached. Just don't tick any of them off by mistake.

6.23. Takeoff Non Normals – Memory Items, Accelerate, Checklists

When non-normals occur during takeoff, common errors include the early commencement of a non-normal checklist prior to acceleration, or inappropriate delaying of checklist memory items.

Non-normals during takeoff differ not at all to other regimes of flight in that **flying the aircraft must take priority over checklist/memory items.** Typically, this is implemented in the following way:

- Checklist Memory Items are delayed until the aircraft is at least 400 ft, flight path and navigation are stabilised and (*ideally*) the autopilot is engaged. Memory items are then commenced and (*ideally*) completed prior to acceleration and flap retraction.
- Non-Normal checklists (*whether associated with Checklist Memory Items or not*) are delayed until the aircraft is clean, CLB/CON thrust is selected and terrain clearance is assured (*if not necessarily achieved*). All non-normal checklists should be complete, the EICAS reviewed and cancelled prior to calling for the After Take Off Checklist.

As always there are exceptions to the rules (*guidelines!*). If you have a Flap NNM and you're waiting until the flap is retracted before commencing the associated NNM procedure(s), it could be a long wait …

Other cases where we see exceptions to common sense guidelines include a ❑ **FIRE APU** on takeoff may be one of these. Despite not including any Memory Items to fight the fire, delaying the checklist until the aircraft is clean would seem to be a significant risk that Boeing are clearly will to take (*remembering how far back the APU is in this aircraft*) – but you may not be. One might say this is a response by a B777 pilot who misses the days when ❑ **FIRE APU** had memory items … but …

- One option would be to commence the checklist at 400 ft (*much like a Recall*), halting it to accelerate and clean up once the fire bottle is discharged.
- The QRH allows the Captain to call for any checklist by memory (*whether or not it contains memory items*), so another option would be to do the immediate actions of the APU Fire Checklist from memory at 400 ft, prior to acceleration.

Neither of these are recommend techniques and if it's your intent to do it this way – you'll want to (a) have a clear idea in your mind about how you'll unambiguously call for this at low altitude after takeoff and (b) ideally discuss it beforehand …

6.24. STATUS Messages

EICAS STATUS messages result from a loss of system redundancy and affect the dispatch of the aircraft, but not usually the operation of the aircraft. During pre-flight (*and outside of the inhibit periods*) the occurrence of a new STATUS message is indicated by the blue **STATUS** prompt and the messages themselves reviewed through the EFIS Control Panel **STAT** display switch.

System/Equipment faults that are reflected by Status level messages (***or higher***) prior to "Dispatch" *(as defined in the A1/MEL)* must be resolved by the DDG/MEL prior to engine start for the purposes of dispatch compliance.

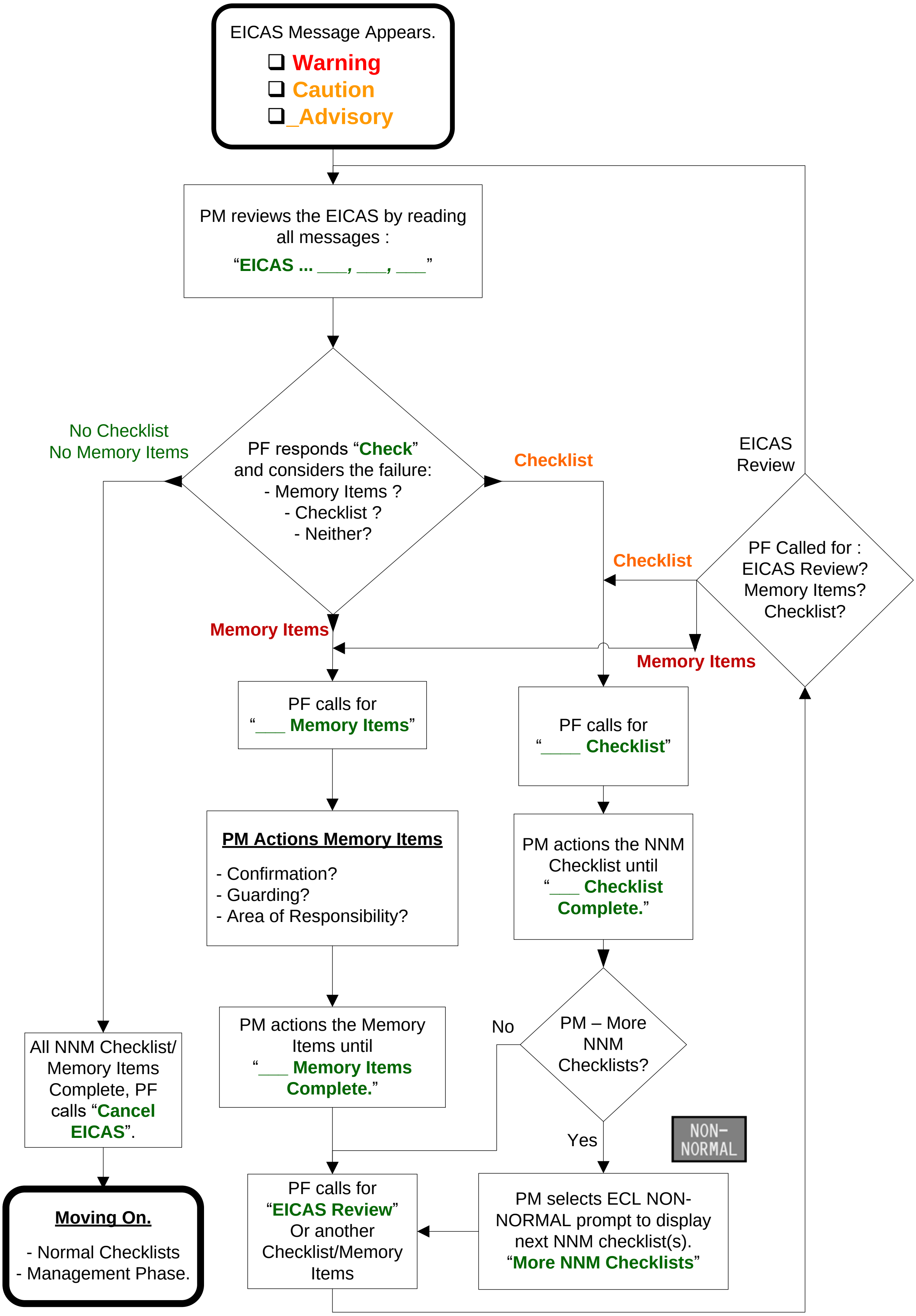
After engine start the **STATUS** prompt is inhibited and EICAS Alert Messages are the primary means of alerting flight crew to non-normal conditions or incorrect configuration. Status message that occur after engine start are not relevant to dispatch, which is why the **STATUS** prompt is inhibited. Such messages will still collect in the status page and can be reviewed whether or not the prompt appears. Any status messages that occur at this stage that are also relevant to the current flight leg will be accompanied by an associated EICAS alert message.

Such messages at this time are relevant for the next dispatch of the aircraft. For example, if you're taxi-ing at Sydney for Los Angles and bring up the status page – any message appearing there is directly relevant for the dispatch Los-Angeles to Sydney, if not your flight. So … if you're taxiing Dubai for Tehran and notice a significant Status message (say, **FLIGHT CONTROLS**) – this will impact your turn-around from Tehran, depending on the level of technical support available. Despite this, the practice of referring to the Status page after start is not SOP and is typically discouraged.

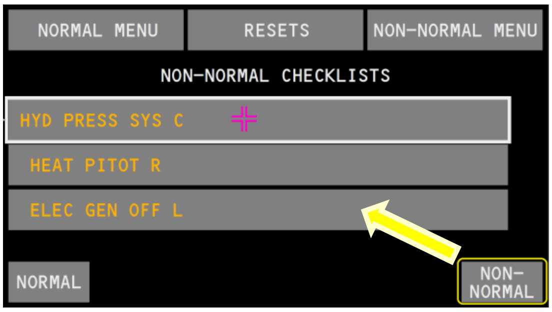
Some crew members have the habit of checking EICAS Status Messages at times that may seem un-related to dispatch. This could include preparing for the arrival briefing, or prior to a crew handover inflight. While nominally such diligence is rarely necessary or relevant – I don't see that it should be discouraged since it promotes a general improved awareness of the status of the aircraft holistically – and it doesn't really hurt anything, does it? As long as you retain the knowledge that anything on the Status Page (*in and of itself*) is unlikely to be directly relevant to this sector – but could well be relevant to the next one …

6.25. EICAS/ECL NNM Checklist Cycle

This completes the discussion of the EICAS/ECL NNM checklist handling cycle. Using the tools above, a crew will be able to handle any significant system failure or failures that generate multiple NNM EICAS Checklist/Memory Items. An overview diagram is shown below to provide a big picture overview of the cycle – please note that not all of the included steps are relevant to every NNM situation.



6.26. NNM Checklist(s) Complete … What's next?



When a NNM checklist is complete, crew focus should return to the EICAS message display to determine what action should be taken next. If there are outstanding NNM checklists to complete (override, etc) then apart from checklist icons (❑) in the EICAS message display, the ECL focus (the cursor) jumps to the bottom right hand corner NON-NORMAL prompt. At this point, the PM can select the NON-NORMAL prompt and display either the remaining checklist, or the NNM outstanding checklist queue.

Note that it is possible for there to be incomplete checklists in the NNM queue without icons showing on the EICAS message display.

It's good practice for the PM to prompt the PF with the fact that more NNM checklists remain to be completed ("**More NNM Checklists**") if the NON-NORMAL prompt is showing on the bottom RHS ECL. PF can then decide to simply call for one of the outstanding NNM checklists (as shown on EICAS) or call for another EICAS review.

Otherwise the cursor will jump to the bottom left hand corner and the NORMAL MENU prompt. At this point, it is advisable for the PM to leave the cursor there while the EICAS is Reviewed and Cancelled, prior to calling for any NM checklist applicable.

6.27. Engine Failures - Overview

The basic EICAS/ECL techniques for handling engine failures at all stages of flight (*or on the ground*) stem from the procedures used when the engine failures after V_1 on takeoff.

From the previous discussion on (**Takeoff Non Normal Calls**) while the PM may call the EICAS and specifically identify the engine/malfunction ("**EICAS Engine Fail Left/Right**") it is important not to commence the assessment phase until called for by the PF once the aircraft is at a safe height.

- PF's primary responsibility is to **fly the plane**.
- PM may call the EICAS message(s) ("**EICAS Engine Fail Left/Right**") or "**Engine Problem**", but this call should not prejudice the safe flight of the aircraft ("**Rotate**", "**Positive Rate**", "**Gear Up**", etc)
- At a safe height (>400 ft RA), flight path stabilised and navigation established, PF calls "**Identify the Failure**" (**Failure Assessment**)
- PM conducts the assessment, which should result in the identification of the failed Engine, analysis of the malfunction, and a recommendation for the appropriate Non-Normal Checklist/Memory Items.
- PF verifies the assessment and calls for the appropriate checklist Memory Items "**___ Memory Items**" (*if required*).
- PM will action the Memory Items and when they are complete, advise the PF "**___ Memory Items Complete**" (*if required*).
- PF then continues with the takeoff, including acceleration, clean-up and a mini plan, before moving to the NNM Checklist phase. Note that the checklist that should be called for (first) is the one associated with the completed Memory Items.

Refer to **Acceleration, Configuration and Memory Items** for a discussion on Acceleration, Configuration and Memory Items. Refer also to **AICC – Announce, Identify, Confirm, Commence**.

An engine failure at altitude or on the ground, runs substantially the same way. Fly the aircraft, call the failure, analyse the failure, Memory/Checklist Items when appropriate (*no need to confirm memory items on the ground …*).

6.28. Takeoff Non Normal Calls

> **QRH MAN 1.2 : Rejected Takeoff**
> *During the takeoff, the crew member observing the non-normal situation will immediately call it out as clearly as possible.*
>
> **FCTM 3.5 : Initiating Takeoff Roll**
> *The PM should monitor engine instruments and airspeed indications during the takeoff roll and announce any abnormalities.*

The issue of calling Non Normals during takeoff is potentially a CRM discussion paper. There is no definitive industry viewpoint on the correct handling of this issue - policies tend diverge along company lines, rather than manufacturer. Welcome to Aviation.

The following should be taken into account by the First Officer/PM when calling failures during the takeoff roll.

- EICAS inhibits the Master Caution/Warning light and aural indications for various messages at various stages during the Takeoff. Essentially, if there's no light and sound, it could be said that Boeing has already decided the failure should not affect the safety of the flight. That does not mean don't call it – but even so …
- EICAS does **not** inhibit any caution or warning failure **messages** during takeoff. If a failure occurs during the takeoff roll such that the associated Master Warning/Caution light and associated Aural is inhibited – the message still displays on EICAS. The QRH & FCTM indicates that these messages should be called.
- New Captains using the occurrence of Aural alerts during takeoff as their Stop/Go decision should note that the **Cabin Alert** message and **High Low Chime** is **not** inhibited at all during takeoff. The First Officer may be quite guarded in the calls made during takeoff, but a crew member down the rear trying to speak to a friend in the mid galley and dialling carelessly will generate a tone on the Flight Deck at any time during the takeoff roll …
- The crew should **not** initially identify an engine when calling an engine fire/failure, **unless calling the specific EICAS message**. It may be quite acceptable at various phases of takeoff to call "**EICAS Engine Fail Left**" – it is not acceptable to look at engine parameters at low level and advise the PF "**I think the LEFT engine has a problem …**" This is to avoid prejudicing any failure assessment that is performed at 400 ft after takeoff.
- It is not unusual for the Captain to fail to detect a TAC non-failure during an engine failure on takeoff and trim the aircraft prior to AP engagement. On the other hand, calling the EICAS message "**EICAS Thrust Asymmetry Compensation**" when the inhibit ends after takeoff can be quite useful to the PF, especially if trimming is not happening.
- For the aircraft to suffer a catastrophic engine failure at or after V1, and the crew to work successfully to get the aircraft to 400 feet **without any calls regarding the failure** is probably not a case encouraging situational awareness or CRM.

Confused? As long as the PM calls a failure in a calm and reasoned voice, there should be no reason to believe the Captain will act precipitously during the critical high-speed phase of the takeoff. EICAS messages called by the PM during takeoff or airborne should be prefaced with the standard call "**EICAS**". Additionally there's value once the Landing Gear is retracted with flight path and aircraft performance (*at least initially*) under control in calling "**EICAS Engine Fail Left/Right**" and referring to TAC status (such as "**EICAS Thrust Asymmetry Compensation**"; or even "**TAC is Working**" if the PF is observed trimming the aircraft), to provide some confirmation to the PF that the PM is in the loop and to promote the awareness and flow into the NNM process. Problems without EICAS messages such as EGT exceedances should be brought to the PF's attention, again without causing excitement.

When calling failures that may or may not affect the safe continuation of the flight, the following two principles should be taken into consideration:

- Close to V1, nothing should prejudice the Captain's ability to decide the fate of the takeoff.
- The period between V1 and Gear Retraction is crucial to Engine Out and the crew should concentrate on protecting the task of rotation and when appropriate confirming positive climb and raising the landing gear. The aircraft may well get airborne engine out with the gear staying down, but it won't fly very well.

Finally note that in the event of a call regarding the status of the aircraft from the First Officer anytime during the takeoff roll, the correct response from the Captain is either "**STOP**" or "**GO**", which puts the discussion in context, don't you think? It's THAT decision that the Captain has to make, and needs the relevant information for.

6.29. Recurring ❑ GND PROX SYS Checklist

> **3 Ground Proximity (GND PROX) FLAP Override (OVRD) Switch**
>
> Push (OVRD visible) –
> - inhibits TOO LOW FLAPS alert
> - EICAS advisory message GND PROX SYS will be displayed when airspeed greater than 250 knots for more than 60 seconds

Several checklists – including the ❑ ENG FAIL Checklist – result in the selection of Flap 20 for Landing – and therefore require the selection of the **GND PROX FLAP OVRD SWITCH . . . . .OVRD**.

One common consequence of this is the ❑ GND PROX SYS Checklist, which appears/disappears/reappears as the aircraft indicated airspeed is varied above/below 250 knots.

6.30. How NOT to do a Checklist

There are times when the Captain may elect NOT to perform a checklist. This is usually associated with a perceived lack of time to complete the checklist and the increased workload associated, during a critical phase of the flight, such as commencing an approach. This issue most often arises in connection with the ❑ FUEL IMBALANCE Checklist.

During an Engine Failure After Takeoff event followed by return to the departure airport, the need to do the Fuel Imbalance checklist usually arises. Often this occurs in the approach phase of flight, when it may be inappropriate to commence a NNM checklist, and the question arises - how to **not** do (or how to delay) a checklist.

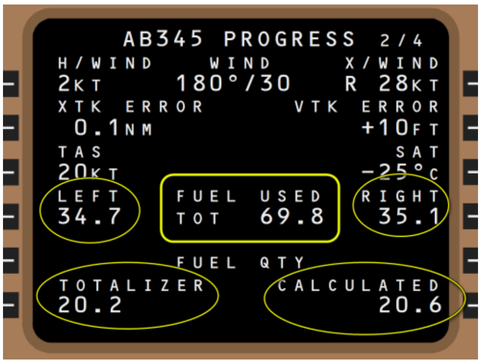
There are three basic requirements that should be considered in this situation.

- The Captain may elect to halt or not to perform a checklist, but the effect on flight safety of that action must be considered and ideally, mitigated.
- A checklist, if started but incomplete, should remain displayed on the lower MFD.
- An EICAS message should not be cleared (cancelled) from the EICAS until any associated NNM checklist has been completed.

With respect to Fuel Imbalance – generally the answer to this question depends on the time remaining in flight – it's the responsibility of the Captain as to which of the following options is exercised. It is poor airmanship to dismiss this checklist based on the assumption that the imbalance is not aerodynamically significant. This is only part of the checklist – the first thing the Fuel Imbalance checklist does is ensure the imbalance is not the result of a Fuel Leak.

- Enough time to complete the checklist to fuel balancing in progress – Downwind?
- Enough time to open the checklist and ensure there is no leak, then hold the checklist – Base?
- Not enough time to open the checklist. Leave the EICAS message displayed.

When the Captain feels insufficient time exists to commence the checklist but seeks to confirm (*or preclude*) a Fuel Leak prior to landing, a basic comparison between the following three L/R values should ensure there is no leak. These values should be looked at critically to ensure they add up, and that the imbalance is justified by the asymmetric fuel usage associated with the operative engine.



- L/R Fuel Tank Quantities
- FMC Progress Page 2 L/R/Total Fuel Use; Calculated vs Totalizer quantities.
- L-R Failed/Operative Engine

The issue of NOT running a NNM checklist also arises when Fuel Jettison is underway during asymmetric flight. Understandably crew may choose not to balance fuel during jettison (see **Fuel Jettison & Fuel Imbalance**) – but the implications of not running the NNM checklist must be considered.

There may be times when the crew manage to clear the EICAS even though an associated NNM checklist is incomplete. This includes SOP application of EICAS Review/Recalls as per phase of flight requirements. Additionally, keeping EICAS clear facilitates the quick detection of subsequent NNMs. In this case the acceptable compromise is to ensure any incomplete checklist is kept on the MFD. The MFD may be used for other purposes, but on completion, the incomplete checklist must be returned to the MFD.

Note that if you have a NNM with a checklist in progress and manage to work yourself into the situation where the associated EICAS message is not displayed (cancelled); the associated checklist is incomplete; and the ECL is not displayed, the aircraft will figure you've forgotten something and prompt with ❑ CHKL NON-NORMAL to highlight your error – see **Incomplete NNM Checklist Handling**.

6.31. Additional Notes – Paper QRH

> **Fuel Leak**
>
> Condition: A fuel leak is suspected for the reasons listed in the Additional Information section of this checklist.

Boeing have begun incorporating an "**Additional Information**" section at the end of NNM checklists. Presently this feature exists for the **Ice Crystal Icing**, **Airspeed Unreliable**, and **Fuel Leak** (and **Bomb Threat**) checklists. It is interesting to note that these items are more appropriate to the beginning of the checklist as they are used primary to identity a non-normal.

Boeing have moved these items to the end of the checklist in order to not have the crew page through long lists of items (*see the* ❑ **Fuel Leak** *checklist*) before actioning important items.

> ▼Fuel Leak continued▼
>
> 15 Choose one:
>
> ◆Center tank leak is **confirmed**:
>
> ►►**Go to step 16**
>
> ◆Center tank leak is **not** confirmed:
>
> Resume normal fuel management.
>
> ■ ■ ■ ■
>
> 16 Continue to use all center tank fuel.

On the ECL this (*sort of*) works ok, because even if the checklist finishes in the middle – the Additional Information is still there at the end of the ECL for the crew to read.

However when running the paper checklist – when you read this section, and answer "**No** – *Center tank leak is **not** confirmed …*" would you then know to skip to the end of the paper checklist and review the additional information – or would you close the checklist at the end of checklist marker (■ ■ ■ ■)?

When you see (*at the beginning of the checklist*) a reference to **Additional Information**, ensure you make a point of reviewing this section at some point during checklist execution.

Ice Crystal Icing	Airspeed Unreliable	Fuel Leak
One or more of the following can indicate ice crystal icing: • Light to moderate turbulence • Static discharge around the windshield (St. Elmo's fire) • Smell of sulfur • Smell of ozone • Humidity increase An erroneous TAT indication can occur as a result of ice crystals blocking the sensor. The erroneous indication can last from one minute to more than 20 minutes. TAT normally should increase approximately 2 degrees Celsius per 1000 ft of descent.	One or more of the following may be evidence of unreliable airspeed or Mach indications: • Speed/altitude information not consistent with pitch attitude and thrust setting • Airspeed or Mach failure flags • PFD current airspeed box amber • An amber line through one or more PFD flight mode annunciations • Blank or fluctuating airspeed display • Variation between captain and first officer airspeed displays • Radome damage or loss • Overspeed warning • Simultaneous overspeed and stall warnings One or more of the following EICAS messages may show: **AIRSPEED LOW**; **GND PROX SYS**; **HEAT PITOT C**; **HEAT PITOT L**; **HEAT PITOT R**; **HEAT PITOT L+C+R**; **NAV AIR DATA SYS**; **OVERSPEED**; **SGL SOURCE AIR DATA**; **SGL SOURCE DISPLAYS**; **WINDSHEAR SYS**	Reasons that a fuel leak should be suspected: • A visual observation of fuel spray • The total fuel quantity is decreasing at an abnormal rate • An engine has excessive fuel flow • The **FUEL DISAGREE**; and/or **FUEL IMBALANCE**; and/or **FUEL QTY LOW** message(s) show on EICAS

6.32. EICAS ❑ CHKL NON-NORMAL

This message was introduced with AIMS blockpoint 17 and enforces the ECL NNM handling guidelines of **Interrupting a Checklist …** and **How NOT to do a Checklist**.

It should be noted that despite the ❑ icon on EICAS there is no NNM Checklist as such for this message (*just the condition statement*) – the checklist that has to be completed to permanently remove this message is the actual incomplete NNM checklist in the EICAS queue.

[] CHKL NON-NORMAL

Condition: There is a hidden non-normal checklist. All of these occur:
- A non-normal checklist is not complete
- The ECL is not displayed
- The related EICAS message is not shown

In essence, if you have an incomplete NNM checklist, the related EICAS message has been cancelled or self-cleared, and the ECL is not currently displayed (*either a NM or NNM checklist*) – EICAS warns you that you may have forgotten that a non-normal checklist is still active. The following rules will keep your operation clear of this message:

- Keep the EICAS message displayed until the associated ECL NNM Checklist is Complete.
- Failing that, keep any incomplete NNM checklist displayed on the ECL. If the MFD is required for another purpose (*such as a NM Checklist, COM or Synoptic*) – use it, but return it to the incomplete checklist when your other requirement is finished.

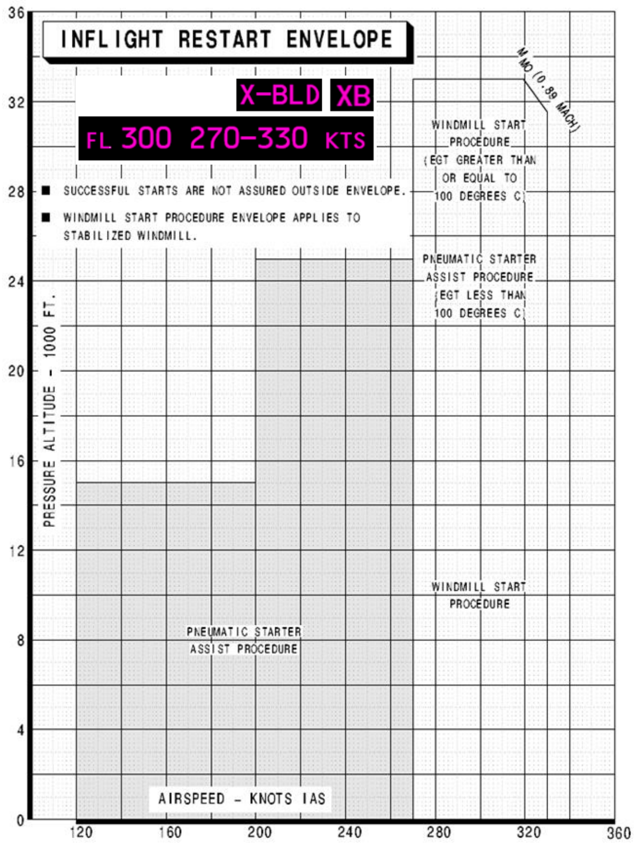
In practice – there are a number of occasions where this message displays on EICAS as a useful remind to crew of what they are to do next, for example:

- After an ❑ **AUTOSTART** malfunction, while the EICAS message disappears with **ENG SHUTDOWN**, the checklist remains in the queue. Since there's a NNM checklist to be run, and it's not displayed … you get ❑ **CHKL NON-NORMAL**
- After an ❑ **CABIN ALTITUDE** -> **Rapid Descent**, if the checklist was not run on descent and the Cabin Altitude message goes away as the aircraft reaches 10,000 ft Cabin Altitude - ❑ **CHKL NON-NORMAL** – will display to remind the crew this checklist remains.

In summary - anytime you have a NNM in progress, either the EICAS Message or the ECL Checklist should be displayed. Naturally there are exceptions – the classic being the EICAS ❑ **PACK L/R** messages during a Packs Off Takeoff.

6.33. Engine In Flight Start Envelope

Boeing/GE publish an assured in flight start envelope in the aircraft AFM. Outside of this envelope, a successful engine re-light is not assured. The AFM is not always available to the crew, so re-light envelope guidance is provided through the EICAS.



The following discussion is background information only.

EICAS display of the assured restart envelope comprises of an Altitude/Airspeed range display and an XB/X-Bleed indication.

The altitude/airspeed display is relatively straight forward.

Altitude is either current altitude or the maximum attitude for an assured re-light (FL330). Airspeed displays the envelope for an assured start – whether windmill or starter assist.

The X-Bleed (*or compacted XB*) indication is displayed when the aircraft is either

- not in the windmill envelope; or
- in the windmill envelope but EGT is below 100°C

The cross bleed start indication will displayed when the aircraft is above the altitude where use of starter assist assures a start (FL250).

This combination of indicators can occasionally be misleading.

ALT	IAS	Alt/Speed Display	X-Bld
F170	180	F170 : 200-330 Kts	XB
F280	240	F280 : 270-330 Kts	XB
F350	240	FL330 : 270-330 Kts	XB
F350	290	FL330 : 270-330 Kts	XB*
* XB is displayed if EGT is < 100°C			

7. Non Normal

7.1. Non Normal Management Model ANC-AAM

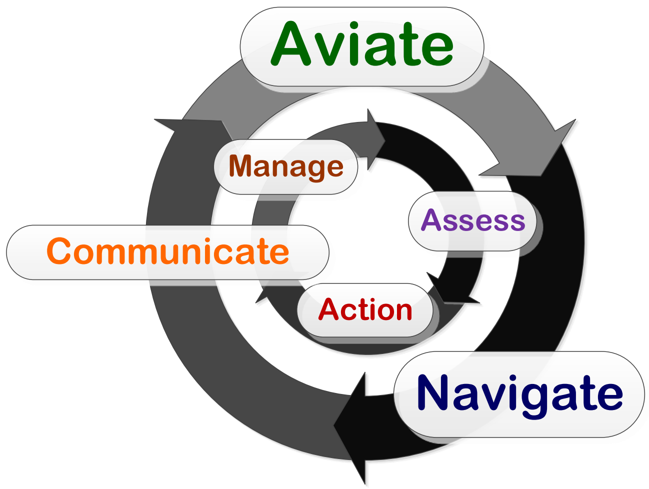
Training organisations use a Non-Normal Management model that can be applied to any non-normal circumstance in the aircraft. The model documented here is summarised as **Aviate, Navigate, Communicate** and **Assess, Action, Manage.**

Aviate Navigate Communicate (ANC)

ANC is an axiomatic industry standard to assist crew in task prioritisation at any stage of flight – not just NNMs.

- **Aviate** emphasises aircraft flight path control – both PF actioning flight path control; PM monitoring flight path and the PF.
- **Navigation** is a priority with the inherent aspects of Terrain (EOP) and Weather clearance, and any wider navigation goals.
- **Communication** follows once the aircraft flight path is assured and short-term navigation has been agreed and implemented by the crew.

It must be appreciated that ANC (most particularly **Aviate**) underlies all NNM management. At no point during flight should the instructor be able to lean forwards and ask "**So … Who's flying the Plane?**"

Non-Normal Management Model	Aviate ▶	Navigate ▶	Communicate
	Power / Attitude / Performance Flight Path Protection Auto / Manual Flight Modes	Engine Out Procedure Terrain Escape Route Weather/Traffic/Clearance	ATC – Mayday / PAN Immediate Needs
Assess ▼	EICAS Alerts Engine Indicates External Indications		
Action ▼	Aircraft Configuration Checklist Memory Items Non-Normal Checklists EICAS Review Normal Checklists		
Manage	Diversion/Return Decision Fuel Jettison/Overweight Landing Communication FORDEC (as required)		

Assess Action Manage (AAM)

AAM provides structure to the less immediate non-normal handling sequences for crew. After ANC, AAM orders and slows appropriately the next response of the crew to the NNM event.

- An **Assessment** phase requires crew to slow down, review indications and think prior to selecting the …
- **Action** which can range from memory items, NNM checklist, or just the agreement that an immediate response is not required.
- **Management** of the NNM at the end of AAM releases the crew into the more traditional handling aspects of decisions relating to return or diversion; weather and terrain assessment; aircraft configuration; passenger needs; aircraft performance assessment etc. At this point FORDEC becomes the relevant tool to use as required – see FORDEC

Change

Should the scenario change (for example a change to the current NNM, an additional NNM or a change to the conditions – weather, fuel, passengers, etc) the pilot may well be required to abandon the current process (whether Navigate/Communicate or Assess/Action/Manager) and return to **Aviate** – Fly The Aircraft.

ANC AAM Summary

ANC and AAM do not exist in isolation. ANC overrides any sequence of events from the commencement of the takeoff roll until the safe completion of a landing. AAM is used regularly during various phases of flight in response to external stimuli to the crew – for example:

- During acceleration, a failed hydraulic system results in the EICAS alert ❑ FLAPS PRIMARY. The crew response? First response is always "**Fly The Aircraft**" – **ANC**. Then crew will the **Assess** the failure, understanding that the FLAPS PRIMARY alert indicates that the flaps are attempting to retract using the secondary system. As such, the only **Action** required is perhaps to monitor airspeed as flap retraction will be slow. The flap failure will involve itself later in the **Management** phase as a Fact when deciding the final disposition of the flight.
- Having completed the acceleration and flap retraction phase of the takeoff – the crew now have to decide what to do next. **ANC** requires that the crew ensure continued safe flight path and suggests the requirement to make a short term **Navigation** decision. While no checklists have been commenced, the crew are aware they've lost a hydraulic system from the EICAS messages. This navigation decision is typically between continuing away from the departure airfield; diverting to a takeoff alternate (*as discussed on the ground during the Departure Briefing*); or requesting a holding pattern above MSA from ATC – this navigation intent will require **Communication** to ATC.

The 777 EICAS incorporates **AAM** as part of the Review/Memory Items/Checklist/Notes cycle of NNM response (see **EICAS/ECL NNM Checklist Cycle**). During the above scenario, EICAS prompts the crew during the takeoff with a series of alert messages (**WARNING**, CAUTION, _ADVISORY) – some of which have checklists, some of those checklists require memory items. ANC requires that crew ignore these during the first critical phase of flight to 400 ft (*unless ANC is compromised*). At 400 ft with ANC established, the crew **Assess** the need for a response and **Action** the required memory items. ANC also requires that crew ignore the need for checklists until the aircraft is at a safe height and configuration. Having cleaned up and ensured terrain clearance – the crew **Assess** the EICAS and choose a NNM checklist to **Action**. When this is complete, they return to EICAS and **Assess** the next for any further NNM checklists to **Action**, and so on. During each of these checklists, the wider implications of the failure and equipment loss are collected by the ECL in the form of Notes, which will be utilised by the crew later during the Management phase, as they FORDEC their way to a decision.

7.2. Fly The Plane

In a training environment, these words, this thought process, the actions associated – all should be foremost in a Trainee's mind.

- Instructor asks you "**What would your initial actions be in the event of an engine failure at altitude?**" The answer is: "**Fly The Plane.**"
- Instructor asks you "**What would you do in the event of an FMA VNAV ALT annunciation when you engaged VNAV prior to commencing an NPA?**" The answer is: "**Fly The Plane**"
- Instructor asks you "**Are you buying the beer in the pub tonight?**" The answer is "**Yes**" and "**Fly The Plane**"

Then, having decided that Fly The Plane will be your axiom – what does that actually mean? For engine malfunctions, see **Fly The Aircraft – What does it mean?**

7.3. Incomplete NNM Checklist Handling

Boeing have introduced an EICAS message that highlights to crew that not only is there an incomplete NNM checklist, but that (a) the associated EICAS message has been removed, and that (b) the ECL is not in use (*displayed somewhere*). If you're following the EICAS/ECL Procedures/Techniques in this document – this should not occur.

[] CHKL NON-NORMAL

Condition: There is a hidden non-normal checklist. All of these occur:
- A non-normal checklist is not complete
- The ECL is not displayed
- The related EICAS message is not shown

There are times when crew are required to deviate from the standing EICAS/ECL paradigm of progressing through EICAS alerts and any associated NNM checklists until completion. Classic examples include waiting for ❑ FUEL IMBALANCE or ❑ FUEL JETTISON to complete, or deciding not to action a NNM checklist because landing is imminent. For this latter example, refer to **Interrupting a Checklist …**

In essence, anytime the crew find themselves halting a NNM, or choosing not complete a NNM checklist as instructed by EICAS – either the associated message or the checklist should remain displayed. Logically it's simplest to leave the EICAS message displayed and choose to run the checklist at a more appropriate time; however, the requirement to complete an EICAS Review/Recall can get in the way. Additionally - particularly in the scenario of a failure/failures with multiple EICAS messages - leaving multiple (*but mostly dealt with*) messages displayed on EICAS exposes the operation to the risk of subsequent messages going un-noticed. In this case, clearing the EICAS but ensuring the outstanding checklist remains displayed on the MFD meets the need. The ECL can be used to run NM or other NNM checklists in the meantime – as long as the ECL is in use, the ❑ CHKL NON-NORMAL message will not display.

7.4. Confirming Memory Items/Checklist actions

Often the PM falls into the habit of confirming all checklist actions with the PF during NNMs – especially when new to the aircraft. There is actually a very limited set of controls that need the confirmation of the other crew member prior to being actioned during a Memory Item/Checklist. There is no need for the PM to confirm **all** the items in a NNM checklist with the PF. See **Actions Requiring Confirmation**.

7.5. Slow Down, Enjoy the Emergency

Yes, it's an airborne emergency. Yes, quick action may be (*rarely*) required. Yes, you knew it was coming (*in the simulator*). Yes, you know how to deal with it. All of these are **not** reasons to justify rapid and possibly ill-considered actions during a Non-Normal. You are usually advised to treat the simulator like the aircraft. In that case – **slow down!** Statistically, this is the only engine failure you ever going to see – slow down, enjoy it, you may as well take the time to get it right.

Indications of the need for a crew to slow down include responses such as hunting for the Engine Fail checklist in the ECL before the ❑ **ENGINE FAIL** message has even made it to the EICAS. The response to an engine failure (*or any malfunction*) should include a **failure analysis**, prior to selecting the checklist to be actioned.

Another indication of rushing is launching into the Cabin Altitude Memory Items prior to the (*relatively*) slowly climbing cabin reaching 10,000 ft. Ideally, it would be nice to confirm an inability to control the cabin, prior to descending to 10,000 ft and committing the aircraft to a new destination for a malfunctioning outflow valve.

The correct action, implemented after some thought and analysis, will almost always provide a better solution – or at the very least the same one – than an impulse response, irrespective of whether it is right or wrong. In this regard – two heads are usually better than one.

Checklist memory items and checklist actions should also be completed in a calm, unhurried, crew co-ordinated manner. While items which are irreversible or have a significant impact on flight safety are generally confirmed by both pilots – there are still many items in the various checklists and memory items which are not – but can make life very difficult when you action the wrong switch, or the right switch in the wrong manner.

7.6. ECL Checklist Title Usage

Crews are encouraged to use the ECL in a formalised, regimented manner. Good habits practiced during times of low stress and workload transfer to periods when the workload and stress is higher.

- Call for a checklist by its full and correct title "**Engine Severe Damage Separation Left Checklist**"
- Read the checklist title and condition statement in full once the checklist is displayed on the MFD.
- Read the checklist title in full and the completing statement when a checklist is complete "**Engine Severe Damage Separation Left … Checklist Complete Except For Deferred Items.**"

7.7. Dual Engine Fail/Stall – who flies?

The initial indication of a Dual Engine Fail/Stall (*apart from the loss of both engines*) is the reversion to standby electrical power. During those first critical 30 seconds or so, the aircraft is essentially on battery power **and only the Captain has flight displays.** As soon as this is recognised, control should be handed over to the Captain, and First Officer should become the PM to run the memory items. It can be quite a challenge flying a 350 ton glider without easy visual reference to flight instruments.

Some displays are restored as the RAT is successfully deployed, and full electrical capability is achieved as the APU comes online. Control can then be handed back to the First Officer at the discretion of the Captain.

7.8. Wake up the PM

Considering how workload intensive for the PF exercises such as TCAS RA, Windshear low to the ground and Terrain Escape exercises can be – it's interesting how often during these exercises nothing is heard (*or nothing of use anyway*) from the PM.

Just at the time when the PF could really use information like "**Two Hundred RA AND DESCENDING**" during a windshear encounter, the PM is focussed on the same inch square part of the PFD that has the PF's attention and says basically nothing at all. It's worth noting that during events that involve the potential for (*and trend towards*) ground contact (Windshear, CFIT, etc) – calling useful information is a skill that benefits from forethought, just like any other skill. Calling Rad Alt values rather than indicated Altitude tends to communicate the needs of the situation more clearly.

As the PM you're there to assist and monitor the PF – not be caught by the same tunnel focus attention deficit problems that strike the pilot flying the aircraft. Also, a call to ATC (eg "**TCAS RA**") to let them know what's going on is useful when circumstances permit as well.

7.9. FORDEC

While it would seem to contradict accepted thought .. I think that most crew in most situations do not require a **Decision-Making Model** – or at least use their own instinctive model to evaluate situations, decide and implement those decisions. For many situations – such as an engine failure after takeoff – the options are few, were discussed at the Departure Briefing and the way forward clear to both pilots, so they just … do it.

However, when the way forward is not clear – or particularly when there is disagreement over the better solution – FORDEC can be a valuable Decision Making Model.

F	Facts	• What is the full extent of the problem? • Gather all relevant Facts. • A problem which has been well defined at best usually suggests its own solution and at worst prevents the crew from going down the wrong path. • It is important to stay focused on defining and understanding the problem rather than rush to the solution. • There will often be more than just the one problem requiring a solution and they will all need to be carefully considered and then dealt with in order of priority.
O	Options	• What options are available? • Define the different options you have, considering that there may be several possible options to facilitate a safe outcome. • Time can be considered as; critical, available and required. There are very few problems that require immediate action. In the majority of cases, a considered and well-developed plan is going to lead to a safe optimised resolution. • The use of open questions can assist in staying problem centred. "**What do you think …?**"
R	Risk	• What are the risks and benefits associated with each option? • With the given situation, what are the assessed risks in pursuing a course of action weighted against the perceived benefit? For example … - With the given situation, do we return for an immediate landing overweight or do we take up the hold and jettison fuel? - With the given problem, do we land on the longer runway with a crosswind or the shorter runway with a headwind?
D	Decision	• Which option have you decided on? • After spending an appropriate amount of time on the first three steps, the commander must eventually **make a decision**. • This is the step that many people instinctively leap to, however correct application of a management model will lead to a process driven solution that will have initially focused on accurately defining the problem, analysing the options before finally deciding on the solution.
E	Execute	• Execute the selected option. Once the decision has been made, the plan must be put into action
C	Communicate (Check)	• Communicate your intentions. • Once the plan has been executed, the commander must ensure that his intentions are communicated to all interested parties. • This will include the cabin crew and passengers within the aircraft, along with relevant agencies on the ground. • In some models, the C is/includes Check – Check your plan has worked as intended.

For Further Consideration ....

While FORDEC is nominally a decision-making model – FORDEC is also a useful dispute resolution tool. While complex in flight scenarios can benefit from a structured approach to gathering data, stating the problem, risk analysis, solution development, plan implementation considerations, plan resolution monitoring/evaluation and all the other CRM buzzwords – ***nothing complicates what at first appears to be simple than the clear, rational objection of the other pilot to your intended action***.

Final Note.

One needs to continually assess the problem and project the outcomes to determine if new problems emerge from new solutions. Be prepared to repeat the process should there be any changes to the scenario.

7.10. Mayday vs PAN

Boeing documentation does not provide clear guidance on what conditions should result in a Mayday call to ATC, vs what call should result in a PAN PAN PAN. Anytime the checklist calls for **Land ASAP** crews should consider one these calls. The AIP defines the two calls as follows.

MAYDAY : My aircraft and its occupants are threatened by grave and imminent danger and/or I require immediate assistance.

PAN PAN : I have an urgent message to transmit concerning the safety of my aircraft or other vehicle or of some person on board or within sight, but I do not require immediate assistance.

Other considerations are as follows.

- Any time critical failure such as an un-extinguishable engine fire or un-controlled (*or un-determined source*) smoke/fire in the cabin should be a Mayday call.
- Severe engine failures, engine fires, smoke/fire in the cabin (*whether under control and/or source identified*) – should be a Mayday as well.
- Other engine failures, hydraulic failures resulting in significant flight control system loss or single remaining hydraulic source, single remaining electrical source, unreliable airspeed resulting in manual flight with minimal instrumentation – all such failures should result in **at least** a PAN call.
- Where a PAN call has been used and inadequate support from ATC is obtained – crew can consider upgrading to a Mayday.
- There are some countries where the use of a PAN call could create more confusion than assistance from ATC.
- Crew can always declare a Mayday during the initial stages of a NNM, then later downgrade to a PAN call.

7.11. Oxygen Masks

Oxygen Masks are usually donned during one of the few times during NNM operations where time is a significant factor in the successful outcome of a NNM event. This is probably why it's often poorly done in the simulator. Donning an oxygen mask is a simple procedure:

- Place your headset backwards around your neck (*if it's being worn*).
- Grab the Oxygen Mask Release Levers, pull and squeeze to inflate the mask harness.
- Place the inflated oxygen harness over your head and when in place, release the release levers and ensure a comfortable fit. Breathe. Don't forget to breathe.
- Move your headset back over your ears, select Flight Interphone on the RTP (*consider enabling the speaker as well*) and test call "**Captain on Oxygen**". Look for a response from the other pilot.

Note that if you are not using a headset at the time, the speaker should have already been selected, but may require a significant increase in volume in order for the crew to communicate. Glasses (*prescription or otherwise*) are an additional complication and crew should know ahead of time how they will handle prescription glasses in conjunction with an oxygen mask. Experiment in the simulator.

Note that in the event of mask fogging, the combination of switching the Regulator Selector to the EMER selection (*100% oxygen under positive pressure*) and slightly lifting the mask off your face will generate a considerable flow of oxygen and should remove condensation from the interior of the mask.

Removing them successfully is slightly more complicated. When at 10,000ft Cabin Altitude with flight path and navigation established, **someone (*usually the PM*) needs to go first.** Instructors don't like to see both pilots disappearing off to the sides to come off oxygen – "**Who's flying the plane?**" Once the first mask is removed, the Oxygen door closed, the reset switch pushed, the second pilot can then hand over control and have a go. In the sim, hang the mask on the headset hook behind you so you don't run over the tubing with the seat later on ... ask us how we know this …

One final technique – *your instructor will bless you if you master this*. While we usually run around with the intercom active while using headsets – if you do this while wearing an oxygen mask, the sound of your breathing blasts through the intercom like a Klingon disruptor *(particularly, for some reason, into the ears of the Instructor headset)*. The secret is to **turn the intercom off while you're not talking**, and **turn it on only while you have something to say**. And while it's on – because you're talking – ***don't breathe***. If you have something to say that's so long you have to breathe during it, you should either turn off the intercom while you breathe – or consider revising your statement towards brevity.

7.12. Cabin Altitude Memory Items

There are at least a couple more points worth making about Cabin Depressurisation and potential Rapid Descent.

Firstly – note the word **potential**. Not all cabin pressurisation problems lead to Rapid Descents. Sometimes (*ok, outside the sim mostly*) they are controllable through a NNM checklist. It's worth noting that sometimes the crew that takes the aircraft unnecessarily down to 10,000 ft over the Pacific, will have just committed the flight to an overnight on an island somewhere, irrespective of whether the aircraft is successfully re-pressurised.

It's also worth noting that the memory items associated with the Cabin Altitude are a higher priority than an ATC call.

4 **If** the cabin altitude is uncontrollable:

PASS OXYGEN switch . . . . Push to ON and hold for 1 second

Finally, the memory item is "**Passenger Oxygen Switch ... Push to ON and HOLD for one Second**" not "*Look at the EICAS and see if PASS OXYGEN ON is showing, then decide if you feel like activating the switch and move along with your life citizens.*" PM should backup any auto deployment by actioning the required memory item and press the switch.

7.13. Recovering from TCAS RA (or most Manual Flight NNMs)

After a TCAS RA, the PF is now (hopefully) in control of an aircraft that is in complete manual flight – including thrust. The aircraft has most likely deviated away from its previous flight path (*usually either ALT, VNAV ALT or VNAV PTH*) including selected speed. If you have read the comment elsewhere in this document (**Don't throw the aircraft at the Autopilot**) about not throwing your aircraft at the autopilot, you'll know that the answer to this is NOT to engage the AP and hope it fixes the problem. That's not what it's certified for.

During and after a TCAS RA – don't forget manual thrust is required for speed. Without appropriate manual thrust inputs either an over speed or under speed is a likely outcome – fly the aircraft.

- For the recovery, first verify that your altitude selector is where you want to be. If not – call for it to be corrected by the PM.
- Then call for FLCH (*you're manually flying – the switch is not yours to press*). In one press, this mode will engage the auto throttle and the flight director pitch bar in the correct modes to return your vertical flight path to where it needs to be to regain your desired altitude.
- Now consider your lateral mode – do you need Hdg/Trk select or is LNAV doing the job?
- All that remains at this point is to **steer the flight director** and you can **then** engage the autopilot.

One final consideration could be a TCAS RA on approach, where you've been forced to abandon your plan to land. In this case turning the RA into a go-around tends to be the best solution. Precede this with a comment … like "**Ok, we're clear of the traffic, let's turn this into a missed approach, shall we … Go-Around, Flap 20**". You will need your MCP Altitude Selector set appropriately first however.

7.14. Flaps for Go-Around

There is a common misconception that following a Flap 20 Approach/Landing, the missed approach is always flown with Flaps 5 – "**Go-Around … Flaps 5**"

Note: Use flaps 20 and VREF 30 + 20 for landing. Higher approach speeds improve airplane maneuvering characteristics.

Note: Use flaps 20 and VREF 20 for landing and flaps 5 for go-around.

In fact, Flaps 5 in the Go-Around should only be called for when specifically directed by the ECL NNM checklist, which is usually done to improve climb performance characteristics during the missed approach.

Examples where Flaps 5 is **not** called for during a go-around after a Flaps 20 approach include the following.

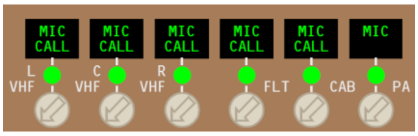
- **STABILIZER** : Flaps 20 is used to provide increased airflow over the tail to ensure sufficient elevator authority for landing. Flaps 20 is maintained during the Go-Around.
- **FLIGHT CONTROLS** : Flaps 20 is used to provide increased airflow over the flight controls and improve airplane manoeuvring characteristics. Flaps 20 is maintained during the Go-Around.

7.15. Setting a NNM Vref – reference the ECL Notes

There are a variety of NNM's that affect the Vref setting for approach in the FMC. Specified by the applicable ECL/QRH Note will be the flap-basis of the speed *(usually either Flap 20 or Flap 30*) as well as a variety of speed additives. Anytime a crew member is setting a non-standard Vref, the ECL/QRH Notes should be directly referenced to ensure the accurate setting of the Vref Flap/Speed selections – don't rely on memory.

Additional references – see **Multiple NNM's and Flap/Vref settings**, **NNM Vref & Speed Additives**, **NNM Approach Speeds**, and **Setting Vref Early**.

7.16. Communication after a NNM – Who You Gonna Call?



In the simulator, we tend to play lip service to the communication requirement after a NNM event. No instructor wants to sit through an extended NITS briefing to the FM, long details to the Company or Engineering, nor an off the cuff, hesitant, convoluted and occasionally alarming PA to the passengers.

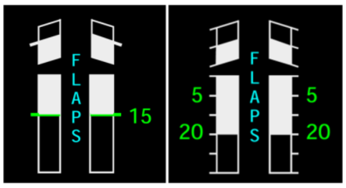
However, these actions must be included in your thinking after a NNM. At least until command training, something along the lines of "**Ok now I'd call the Company … Done**", then "**And now I'd give the FM a NITS briefing … Done.**" Finishing with "**Ok let's tell the Passengers what's going on … Done**" meets the need. Mind you if your examiner/instructor doesn't respond, and you launch into a half thought out cabin PA that in the real world would make you (in)famous on YouTube – who's fault is that?

If you need a crutch to remember who to call after a NNM – look at your primary communications device – the RTP. There's a checklist built right into it. Look through the various possible MIC selections and analyse who you normally talk to through that channel – there's your checklist of who you might need to talk to:

- VHF L - ATC (Distress Call, Assistance Request, Information)
- VHF C (DATA) - ACARS (Weather, Diversion Report, Other Company Reports)
- VHF R - Company.
- FLT Intercom - Ground Engineer(ing).
- CAB - FM, Cabin Crew.
- PA - Passengers

Who to contact after a NNM will vary with the situation, as will the order in which they should be contacted and the information to be provided. Who is told what, how much is communicated, and the order in which it's done begins with remembering to do it in the first place.

7.17. Flaps/Slat Problems & Speed Reduction



Normally during the speed reduction associated with Flap/Slat extension there is no requirement to wait for Flap/Slat extension to complete before reducing speed. If you are at Flaps 1 and call for Flaps 5, as soon as the **5** indication is evident on the speed tape, PF will bug the speed straight away even as the Flaps run to Flap 5.

However, during Flap/Slat failures that use secondary electrical extension such as **FLAPS PRIMARY** and **FLAP/SLAT CONTROL,** crew are advised to wait to reduce the airspeed until **after** the requested flap/slat extension has been achieved. This is due to the slow speed at which the Flaps/Slats extend during these failures. This is particularly important during the extension of Flaps/Slats to Flaps 5, which can take significantly more time.

7.18. Flaps/Slat Problems & Slower Deployment

Flap/Slat extension through the secondary electronic motors such as during **FLAP/SLATS PRIMARY** or **FLAP/SLAT CONTROL** comes with a NNM checklist Note to plan additional time (distance) for Flap/Slat extension.

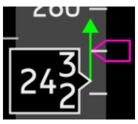
[] FLAPS PRIMARY FAIL

Note: Plan additional time for slower flap operation.

Let's quantify the effects of slower extension. The figures here are not definitive and based on ISA conditions at Max Landing Weight, but do give an idea of the average increase in time for secondary extension. Note that the times shown here under Primary vs Secondary/Alternate are cumulative. The increase in time is approximately 2 minutes, or less than half a hold. From Flaps Up to Flaps 20 takes approximately 10 track miles under secondary extension.

Flap Extension	Cumulative Time *(mm:ss)* Pri	Sec/Altn	Incr
UP → Flaps 1	0:10	1:00	+ 0:50
Flaps 1 → Flaps 5	0:30	1:50	+ 0:20
Flaps 5 → Flaps 20	0:40	2:35	+ 0:45
		Time Increase :	+ 1:55

7.19. Flap Retraction & Speed Trend



When you're performance critical (*engine out*) it's not unusual for your rate of acceleration at the end of the segment to be pretty marginal. Even a well flown engine out departure (*at least initially*) results in a rate of speed increase that isn't fast enough to kick off the PFD Speed Trend arrow. Some of us have been taught (*and have taught*) that we should wait for this arrow before selecting the next stage of flap. **This is not correct**. All you need is at least the minimum speed (for the current Flap selection, and a visibly increasing speed. FCTM refers.

Flap Retraction Schedule

During flap retraction, selection of the next flap position is initiated when reaching the maneuver speed for the existing flap position. Therefore, when the new flap position is selected, the airspeed is below the maneuver speed for that flap position. For this reason, the airspeed should be increasing when selecting the next flap position. During flap retraction, at least adequate maneuver capability or 30° of bank (15° of bank and 15° overshoot) to stick shaker is provided at the flap retraction speed. Full maneuver capability or at least 40° of bank (25° of bank and 15° overshoot) is provided when the airplane has accelerated to the recommended maneuver speed for the selected flap position.

With airspeed increasing, flap retractions should be initiated when airspeed reaches the maneuver speed for the existing flap position. The maneuver speed for the existing flap position is indicated by the numbered flap maneuver speed bugs on the airspeed display.

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7.20. Landing using Flaps 20 Yes/No

19 Choose one:

◆Landing using flaps **20**:

GND PROX FLAP OVRD switch . . . . .OVRD

Note: Use flaps 20 and VREF 20 for landing and flaps 5 for go-around.

►►**Go to step 20**

◆Landing using flaps **30 (performance permitting)**:

Note: Use flaps 30 and VREF 30 for landing and flaps 20 for go-around.

Often at this point during a NNM checklist, crew are observed to dive down into the FMC and select the Flap and Speed setting implied by this question in the checklist. While this is a good procedural technique for several reasons – at this point it's still a little early.

Shortly after this question in the NNM checklist, the crew will be instructed specifically what flap setting and speed additive to use for the approach. In the case of many checklists this may not be the reference speed associated with the flap setting. **As such the proper technique is to wait for the ECL Note advising Flap and Vref additive setting.**

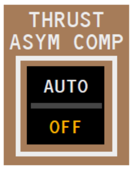
One last consideration could be … **Is this your only (last) NNM Checklist?** If there's another checklist in the NNM queue that might also want a NNM Vref – you might want to delay setting it up until you have the full picture. See **Multiple NNM's and Flap/Vref settings**.

7.21. Dispatch with a NNM

ATA 27 | **777 Dispatch Deviations Guide** | **Section 2**

27-02-08 **Thrust Asymmetry Compensation (TAC) Function**

Interval	Installed	Required	Procedure
C	1	0	



PLACARD

As appropriate

When dispatching with a defect under the DDG, no information is provided to crew as to how the NNM should be handled after start when EICAS detects the fault. One common response by the crew is to override the NNM checklist – this is usually the wrong response.

Run the NNM checklist. Any Notes generated as a result will gather for the Recall/Notes part of the Arrival Briefing/Descent Checklist. Usually these notes are relevant to the operation – because the equipment is actually failed and needs to be taken into account during subsequent flight operations. While running that checklist, any actual switching might need careful consideration, especially if Engineering has already configured (*switched off*) the system.

7.22. Memory Items Complete …

When the PM has completed all the memory items associated with a QRH Checklist, the standard call "***(checklist title)* … Memory Items Complete**" is required. This call is often overlooked by crew. The call is important as it identifies the need for the PF to direct the next phase of the NNM operations – Either an EICAS Review, Call for another Checklist with Memory Items, or complete the associated NNM checklist.

7.23. Slats Drive – Do We Extend the Flaps?

[] SLATS DRIVE

Condition: The slat drive mechanism is failed.

1 Do not use alternate flaps. Asymmetry and uncommanded motion protection are not provided in alternate mode.

Note: Use flaps 20 and VREF 30 + 30 for landing. This provides better handling qualities when the slats are not fully extended.

There is occasionally some confusion on the flight deck associated with the ❑ SLATS DRIVE NNM. A Slats Drive failure leaves the Slats unavailable to the crew. While not necessarily mechanically correct – you can think of this failure as the detection of an asymmetric Slat extension and therefore the FSEU has shut down the affected system to preclude further asymmetric control surface deployment. This is one reason why Alternate Flaps – which overrides the FSEU for **both** Flaps and Slats – is specifically forbidden.

Having been told they must not use Alternate Flap extension, Crew are sometimes reticent to extend Flaps (*not the Slats*) through the normal Flap lever. However, a visual review on the PFD of the nominated QRH NNM approach speed (Vref 30+30) confirms the need for additional flap extension for landing. The checklist also says "**Use <u>Flaps 20</u>** and ... for landing."

7.24. Rapid Descent and the Cabin Altitude Checklist

There is a long-standing CRM principle called Task Protection. Basically, the intent of this is that despite the multi-tasking needs that are placed on a pilot during the complex operation of a multi-crew, automation dependant flight deck – most people can really only do one thing (very well) at a time. Allowing the quality of your current task to be degraded by commencing a second, or even third one is not good airmanship or common sense. Especially when the second and third tasks could well have waited, and the first one involves saving lives.

A case in point is the ❑ **CABIN ALTITUDE** checklist/memory items. Once the memory items are complete and the aircraft is established in the rapid descent, the option of calling for (or not) and completing the associated checklist presents, along with the other NNM event handling aspects of this failure.

In the simulator (*after the adrenaline raising onset to this exercise*) a period of low activity is encountered by the crew, ***and the instructor***. Memory Items are complete, the NNM checklist is held (or not), the aircraft is flat out descending with Speedbrake and the regular sound of Darth Vader breathing can be heard in the simulator. There's nothing to do and the crew are keen as mustard to find something. This is NOT the time to contact ATC for the weather. This is NOT the time to decide where to divert to. This is NOT the time to communicate with the cabin or passengers (*although it is funny to listen to* - "**Ladies and Gentlemen, PSSST PSSST, we have experienced a minor technical difficulty PSSST PSSST with the air conditioning system PSSST PSSST and are descending to ten thousand feet where PSST PSST you can all begin breathing again.**")

Protect Your Task. Your task is:

a) Get the aircraft safely to 10,000 ft (*or MSA; or EDTO Planned Diversion Altitude*)
b) Get yourself and fellow oxygen breathers safely off the oxygen masks so you can talk and plan effectively again.
c) Assess the Flight Path and Navigation – are you safe? Where's the Terrain? Do you need a mini-plan?
d) Complete the Non-Normal Checklists – all of them.

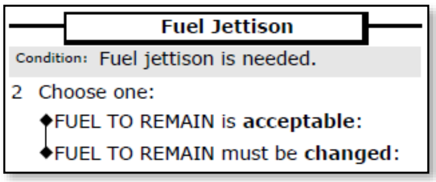
Then it's time to move onwards to ATC, Cabin, Passengers, Company, etc.

It should be noted that in the worst Cabin Depressurisation and Rapid Descent (*such as a door/window blowout*) where the cabin altitude climbs at tens of thousand feet per minute (*or much more*) – it's unlikely the crew will be in any condition to attempt the Cabin Altitude Checklist during the descent. It will be all they can do to breathe and concentrate on flying the aircraft as they attempt to deal with several nasty effects of high-altitude flight including middle ear pain, chilling, internal pressure gas expansion and the potentially associated internal tissue trauma, decompression sickness and hypoxia. On the day – unless as a crew you're up to it – the checklist can wait. Fly the plane.

That covers Rapid De-Pressurisation/Rapid Descents. Not all de-pressurisations are rapid. If the rapid descent is established and if all the memory items are done – and at the direction/agreement of the PF/PM – the ❑ **CABIN ALTITUDE** checklist ***can*** be called for onto the MFD. It can be run by the PM, monitored by the PF and in the very least used to back up the important memory items of the drill. For some reason – this always seems to work well in the Sim, no matter how rapid the depressurisation.

Like so many things in Aviation - while it may not be recommended, this is a valid technique as long as you don't mess it up ... and while you're thinking about this, see **Cabin Altitude Checklist (Silently)**.

7.25. Fuel Jettison, Fuel To Remain – How Much?


Fuel Jettison
Condition: Fuel jettison is needed.
2 Choose one:
◆FUEL TO REMAIN is **acceptable**:
◆FUEL TO REMAIN must be **changed**:

The decision of **Fuel To Remain** when running the Fuel Jettison checklist is usually driven by the target of Maximum Landing Weight, but other considerations should also be taken into account.

More Fuel : Sometimes it's worth keeping another airport within fuel range of the aircraft. If you're looking at returning to Perth (*which means considering fuel to Adelaide*), if the ZFW is high (*which can leave as little as 14 tons*) – an overweight landing may be worth considering.

Less Fuel : Occasionally performance issues such as shorter runways or obstacles in the missed approach may make it worth considering a fuel load less than Maximum Landing Weight – particularly with a low ZFW. The conditions would need to be extreme however, typically for a 10 ton change in aircraft weight, runway distance improves by less than 100 meters and climb performance improves by less than 1%.

7.26. Cabin Altitude Checklist (Silently)

> When a non–normal situation occurs, at the direction of the pilot flying, both crewmembers do all memory items in their areas of responsibility without delay.
>
> The pilot flying calls for the checklist when:
>
> - the flight path is under control
> - the airplane is not in a critical phase of flight (such as takeoff or landing)
> - all memory items are complete.
>
> For checklists with memory items, the pilot monitoring first verifies that each memory item has been done. The checklist is normally read aloud during this verification. The pilot flying does not need to respond except for items that are not in agreement with the checklist. With the electronic checklist, items that are complete (green) do not need to be read or verified. The item numbers do not need to be read.

A technique commonly taught to crews regarding the Cabin Altitude/Rapid Descent NNM Event is for the PM to display the Cabin Altitude Checklist after the Memory Items were completed and then silently verify the completion of the memory component of the NNM checklist during early stages of the Rapid Descent. This technique is not in accordance with Boeing NNM checklist philosophy.

Some justification for this technique can seem to be found in the QRH Checklist Instructions (CI). The last paragraph (*highlighted*) can be read to endorse this technique of verifying the completion of the memory items prior to the PF calling for the Cabin Altitude Checklist.

In fact, this paragraph must be read in the context of those before it. In sequence the events are:

a) Non Normal Event Occurs.
b) At the direction of the PF, both crew members complete the memory items in their area of responsibility without delay.
c) When flight path is under control; clear of a critical phase of flight; memory items complete – PF calls for the NNM Checklist associated with the completed Memory Items.

At this point, the paragraph in question becomes applicable. The NNM checklist is commenced at the request of the PF. If this checklist includes Memory Items – these will be at the beginning of the checklist and if completed (as they should be at this point), the Memory Items will be one of the following two types:

- Closed Loop – PM does not need to read these reference items (ECL).
- Open Loop, Action Performed – PM must read them, check them off as done. PF does not need to respond.

In the event the PM is operating the paper QRH, all items will be read aloud and verified complete by the PM, with no involvement required by the PF, assuming all Memory Items were completed correctly.

So this paragraph does not endorse the silent running of the Cabin Altitude checklist after the completion of the Memory Items, but addresses the normal commencement of a NNM checklist that begins with Memory Items.

7.27. Overriding NM Checklist Items

LANDING CHECKLIST		
Cabin	Ready	PF
Speedbrake	ARMED	PF
Landing gear	DOWN	PF
Flaps	20	PF

Some NNM events result in NM checklist items failing to close the loop in the ECL. Typical examples include Flap/Slat failures such as Flaps/Slats Drive or Flap/Slat Control. Approach and landing is flown with Flap 20. The Landing Checklist has the relevant item **Flaps .... 20** – but despite the flaps being selected and indicating **20**, the NM checklist Flaps items fails to complete the loop. Crew must **Item Override** in order to complete the checklist.

It's important to for crew **not** to focus on the need to override the checklist item – but instead focus on the need to verify that the checklist item has been met – in the example above, make sure the Flaps **are** at 20, before overriding the checklist item.

When the Landing Checklist is run, the PM reads the Reference item " **Flaps …** " and the PF responds with the Required / Selected / Indicated flap position, then confirming the override " **Twenty … Item Override**. "

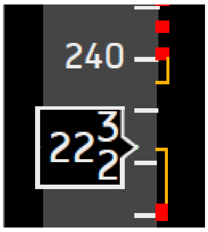
7.28. Slats Drive Go-Around

Slats Drive go-around has been **shown in the simulator** to have unusual flight characteristics. Boeing have confirmed that the simulator is following the same control law as the aircraft, as such crew should expect the aircraft to behave the same way.

Essentially during a go around after a Slats Drive failure, the AFDS in TOGA increases pitch rate slowly to a target of about 8-10° while airspeed continues to accelerate through the flap limit speed. The solution is to either disconnect and fly manually, or potentially a reversion to FLCH should restore correct AFDS speed/pitch behaviour. I'd recommend the manual option …

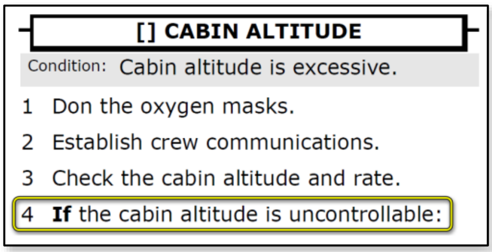
Engine out Slats Drive Go-Around has the same pitch problem, although the result is less marked owing to reduced performance. Note that the use of FLCH in the engine out scenario to recover will reduce the thrust limit setting to the CLB/CON limit prematurely and may compromise go-around acceleration/performance.

7.29. SLATS DRIVE & Flap Retraction



When a ❑ SLATS DRIVE failure occurs during takeoff – particularly at heavy weight – crew need to carefully consider continued flap retraction – as an increasing minimum manoeuvre/stick shaker can combine with the flap/slat limit speed to leave the crew with no room to manoeuvre. Either AIRSPEED LOW or Flap Limit speed exceedances are likely. In a clash, the AFDS will exceed the flap limit speed, rather than fly a speed below minimum manoeuvre speed. Having some altitude under you might make any ensuing under/overspeed event associated with Flap retraction more palatable …

7.30. Cabin Altitude is Uncontrollable?



[] CABIN ALTITUDE

Condition: Cabin altitude is excessive.

1 Don the oxygen masks.
2 Establish crew communications.
3 Check the cabin altitude and rate.
4 **If** the cabin altitude is uncontrollable:

There is a point during the ❑ CABIN ALTITUDE event at which the crew are required to assess whether the Cabin Altitude is uncontrollable. This is typically done through the Duct Pressure and Pressurization System Indications popup, which should be at the bottom of the upper EICAS if you have a pressurisation problem the EICAS can detect. Before we go any further – note that the checklist specifically directs the crew to review the **Cabin Altitude** and **Rate** (of change) – and not the position of the two Outflow Valves, or the Duct Pressure.

It's also important to remember that generally speaking – this is a Boeing and only one thing is supposed to go wrong at any one time. Therefore, if you're considering a ❑ CABIN ALTITUDE, that's one thing. If you're considering a ❑ CABIN ALTITUDE in combination with a previous unrelated pressurisation NMM (OUTFLOW VALVE FWD/AFD; or CABIN ALT AUTO; or Bleed problems for example) – all bets are off, and crew are expected to use their heads to assess the wider implications of this combination of failures. The other thing about Boeing Checklists and Procedures, is they assume up front that all the switches and knobs are in the position they're supposed to be in … But I digress …

At this point, your focus should be on:

- **Cabin Altitude** – an extremely high cabin altitude requires an immediate response (*rapid descent*) in order to take the aircraft down to breathable altitudes. For example – if the Cabin Altitude shows 25,000, it might be controllable *(it's probably not)*, but your immediate requirement is the safety of the passengers.
- **Cabin Rate** – a moderate rate of cabin altitude/climb might indicate a controllable situation. If your Cabin Altitude is 10,200 and the rate of climb 400 fpm – is it controllable? This leads us to the indications the checklist doesn't discuss.

The checklist stops here and doesn't ask you to consider other factors. Such factors *could* include:

- **Outflow Valves** – in most respects, irrespective of whether the Cabin Altitude is 11000 or 31000; whether the Cabin Rate of Climb is 400 fpm or 4000 fpm – if both Outflow Valves are closed, there's not much you can do anyway. Both Outflow Valves Closed mean the pressurisation system is trying to control the cabin and has failed to do so. Except if …
- **Duct Pressure** – if you have duct pressure shown at this point *(and the Outflow Valves are indeed closed)* then that's the complete equation. Again, a lack of duct pressure could indicate no bleed source *(engines/APU)* and further investigation could lead to the recovery of pressurisation. Once again – you're highly unlikely to be at this point without having the forewarning of other EICAS messages that should have assisted you in preventing the cabin altitude problem early.

This doesn't take long to do properly. But it does take longer to do that is typically afforded to it in the simulator when there's a loud bang, a rushing noise, the EICAS ❑ CABIN ALTITUDE alert sounds and crew race into the checklist memory items. During training we often see the PF commencing a rapid descent before the PM has completed an assessment. Remember – **Slow Down, Enjoy the Emergency**. If it's for real, it's likely to be the only one you'll ever get – you may as well get it right.

All that said … things are rarely this complicated. For most of your career when there's a loud bang and rush of air in the simulator and you look down at the EICAS and see indications such as are shown here – the subsequent Rapid Descent will be the correct response. It's just that the real world occasionally offers some alternative scenarios that the checklist accommodates – but simulator scenarios usually don't.

7.31. Cabin Altitude and the Outflow Valves

Based on the **Cabin Altitude is Uncontrollable?** discussion – the question sometimes arises in regard to the manipulation of the Outflow Valves during the Cabin Altitude Checklist "***Uncontrollable?***" assessment. Having donned your mask and established communications – if you look down and (*one or more of*) the Outflow Valves are NOT closed, what do you do now? The obvious answer seems to be … to close them – but let's think for a minute.

Firstly, if the Outflow valves are not closed, and the Cabin Altitude/Rate is excessive – the Outflow Valve is not performing as expected/commanded, and you should see an associated EICAS message relating to either the Outflow Valve(s) (❑ **OUTFLOW VALVE AFT/FWD**) or the Pressurisation Controllers (❑ **CABIN ALTITUDE AUTO**). It is fully realistic to expect that one of these would have manifested prior to the ❑ **CABIN ALTITUDE** alert, and you may well have started the associated NNM checklist. Hence you would have some background to the failure, rather than being thrown into a sudden onset Cabin Altitude/Rapid Descent scenario.

Remember again here that the priority is always the safety of your passengers (*and yourself*). The checklist then directs you to assess cabin altitude and rate and determine controllability. As discussed, if the Cabin Altitude is high, and/or if the Cabin Rate is high – a Rapid Descent is the appropriate response – as required by the Checklist. The point is that once you're established in a FLCH descent to MCP Altitude Selector 10,000 with the autopilot engaged – even if you black out, the aircraft will continue down to 10K and level off and should be there waiting for you to recover and fly. Fiddling with Outflow Valves at this point is usually NOT an appropriate response to what is usually a time critical NNM.

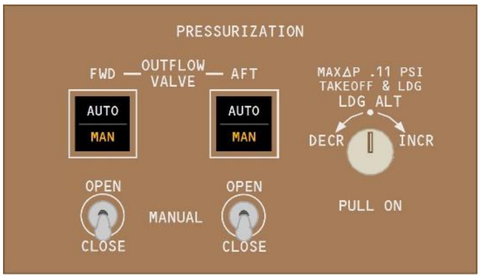
However …

For an Outflow Valve malfunction there should be an EICAS message – but there is in fact a malfunction scenario in our simulator where an Outflow Valve can be failed Open, without an associated EICAS message. The first indication of this will be the popup of the upper EICAS Pressurisation Display at **8400** ft of Cabin Altitude, followed shortly thereafter by the EICAS ❑ **CABIN ALTITUDE** warning. Boeing have been consulted and this failure is indeed valid. To make matters worse – this valve failure is indeed "controllable" and a reversion to manual mode *(without a checklist to guide/instruct this)* would recover Cabin Pressurisation. Fruit.

Cabin Controllable – Outflow Valve(s) Open

Assuming you do have the scenario of one or both Outflow Valves not closed (*with or without an associated outflow valve(s) NNM checklist*) during the Cabin Altitude checklist memory items – Should you close it?

All things being equal (*that is, you haven't been playing with the Outflow Valves or the Packs prior to this point*) the answer to this is usually … No. While there's the possibility you might recover the cabin, your priority should be to commence the rapid descent and deploy passenger oxygen, rather than attempt to fault find a malfunctioning pressurisation system, without the guidance of a checklist. You're unlikely to be able to recover the cabin prior to mask deployment, and at that point things are really getting serious. The safety of your passengers at this point (*and before this point*) are the priority.



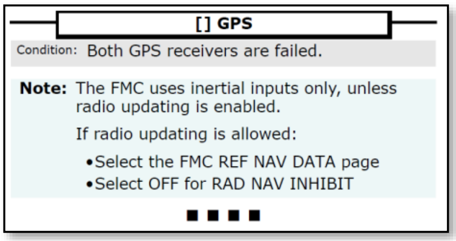
But … Never say Never. You might just be the pilot who looks down at the EICAS on the day and sees **8500** feet on the popup display. You also take in quickly that the Aft Outflow Calve is not fully closed and the forward valve is. You (*correctly*) identify that the problem is probably the AFT valve and the FWD valve is correctly trying (and failing) to compensate. Without a checklist you reach up, go manual on the AFT outflow valve and close it. With a bit of luck, you'll be on your own at the time and won't have to discuss/justify this action to another pilot. The cabin rate reduces and reverses to a descent, and the Cabin Altitude starts a return to normal operations. Congratulations, you're prevented a Rapid Descent and your reward is, you don't get an overnight in Hawaii. You're the Hero of the day and are applauded by all - unless someone does a risk analysis on a scenario where the only pilot left on the flight deck plays with Outflow Valves when confronted with a pressurisation NNM rather than commencing a Rapid Descent … but I digress. See **Single Pilot NNM's in Cruise – the Other Pilot**.

Outflow Valve Reversal During Rapid Descent

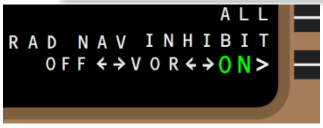
One final note – if your Cabin Altitude is anywhere near your Aircraft Altitude *(whether prior to or after commencing the Rapid Descent)* – one or both Outflow Valves may well be open(ing) in order to reduce the risk of negative pressure differential. This is normal – do not mistake it for a malfunctioning Outflow Valve.

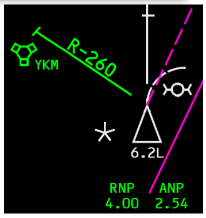
7.32. GPS Failure and Subsequent Navigation

In the event of total GPS loss, the QRH NNM checklist asks the crew to consider allowing the update of FMC position by radio updating “**If radio updating is allowed.**”


[] GPS
Condition: Both GPS receivers are failed.
Note: The FMC uses inertial inputs only, unless radio updating is enabled.
If radio updating is allowed:
•Select the FMC REF NAV DATA page
•Select OFF for RAD NAV INHIBIT
■■■■

Radio Navaid updating of the FMC position is inhibited by default and the FCOM pre-flight NPs. After a GPS failure, if radio updating remains OFF, FMC position fixing (*and subsequent LNAV Navigation*) will be based on IRS Inertial positioning only. On a typical 14 hour flight to KLAX and using LNAV to position onto a precision approach - the aircraft could be anything up to 1nm (*or more*) in error. Crew will need to enable radio updating and closely monitor navigation performance – typically via the EFIS POS functionality.





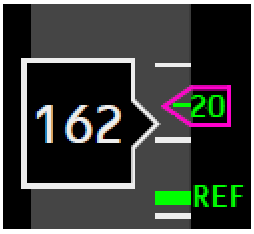
Having run the checklist once, you will have responded to it based on (a) current airspace requirements; with a view of (b) future airspace requirements in the back of your mind. Crew can expect the ANP to move in and out of the (FMC Default) RNP as aircraft manoeuvres through various bearings and distances of terminal navigation aids. Several ❑ NAV UNABLE RNP alerts can be expected, along with the associated NNM checklist each time. As such subsequent run-throughs of the same checklist over and over again may – or may not – be required. Plan for it. Brief for it.

7.33. Fire Engine – Use Your Own Clock

Once that first fire bottle has been fired, the intent of the ❑ FIRE ENG checklist memory item is for the PM to start the onside clock to time for 30 seconds in preparation for the second bottle. Bringing up the ❑ FIRE ENG checklist at this point to use the inbuilt timer instead of your own clock is against the operating philosophy of the EICAS/ECL. In the event that there are multiple checklist or the timer doesn’t function it also exposes the NNM to inaccurate timing.

7.34. Setting Final Approach Speed ... On Final

Occasionally NNM events that require a non-standard final approach speed create a gap between the PFD placard minimum speed for the existing flap configuration and the required final approach reference speed – despite being in landing flap configuration.



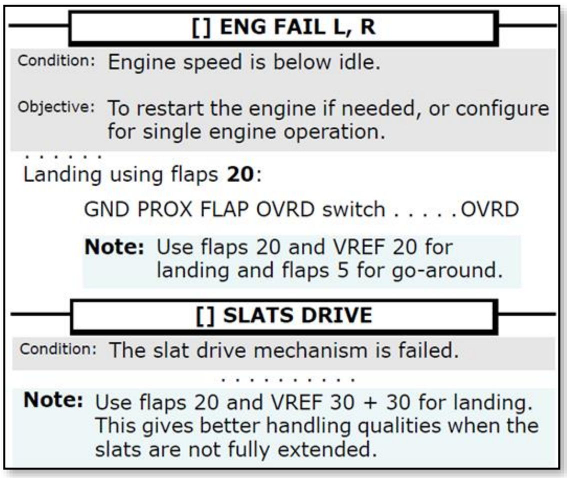
Specifically – while planning to land at Flap 20 because of a NNM, the manoeuvring component of the approach (*vectoring, outbound, turning inbound, etc*) is completed while maintaining the Flap 20 minimum speed.

However final approach and landing will be flown at the NNM checklist specified reference speed (+5 knots) which is often based on VREF 30 (*plus additive*) and can be several knots below the Flap 20 minimum speed.

If this is the case – then the time to set the speed to the **final approach reference speed** is ... when on **final approach** with descent established towards the runway. Intermediate manoeuvring should be accomplished at the minimum flap speed – in other words don’t reduce speed too early (*and don’t forget to reduce it ...*)

7.35. Multiple NNM’s and Flap/VREF settings

When dealing with multiple NNM’s, crew may be confronted by conflicting requirements with respect to selecting a landing flap and a VREF speed. A specific example would be an **Engine Failure** combined with a ❑ SLATS DRIVE malfunction.


[] ENG FAIL L, R
Condition: Engine speed is below idle.
Objective: To restart the engine if needed, or configure for single engine operation.
Landing using flaps **20**:
GND PROX FLAP OVRD switch . . . . .OVRD
Note: Use flaps 20 and VREF 20 for landing and flaps 5 for go-around.
[] SLATS DRIVE
Condition: The slat drive mechanism is failed.
Note: Use flaps 20 and VREF 30 + 30 for landing. This gives better handling qualities when the slats are not fully extended.

In all circumstances crew can nut out the correct Approach Flap / VREF Speed / Go Around Flap setting and estimate a landing distance appropriately through common sense and an understanding of the requirements driving Approach Flap, Approach Speed and Missed Approach Flap requirements.

In this example, Flaps 20 will be the landing flap. The conflict in VREF is settled by choosing the most conservative (highest) VREF speed (VREF 30+30). Since VREF 30+30 is greater than VREF 20, Flaps 5 to improve climb performance in the missed approach is available – and preferred.

7.36. Airspeed Unreliable

The Airspeed Unreliable checklist was revised in light of **Air France AF447** to provide some short-term figures for pilots to rely on. The basic intent of this change is to avoid the fixation that often occurs on airspeed and airspeed related alerts during this failure, to the exclusion of sensible pitch attitudes and power settings to … Fly The Aircraft.

Airspeed Unreliable

Condition: Airspeed or Mach indications are suspected to be unreliable. (Items which can indicate unreliable airspeed are listed in the Additional Information section.)

Objective: To identify a reliable airspeed indication, if possible, or to continue the flight using the Flight With Unreliable Airspeed table in the Performance Inflight chapter.

1 Autopilot disengage switch . . . . .Push
2 A/T ARM switches (both) . . . . OFF
3 F/D switches (both) . . . . OFF
4 Set the following gear up pitch attitude and thrust:
   Flaps extended . . . . . 10 degrees and 85% N1
   Flaps up . . . . 4 degrees and 70% N1

The settings promulgated in the checklist are designed to keep the aircraft in a safe *(if not necessarily desirable)* state clear of high and low speed extremes at all altitudes and weights, for at least as long as it takes the crew to progress through the initial handling and the NNM checklist and obtain values from the QRH for further flight operations.

It's worth noting that the simulator leaves the Flight Path Angle indicator fully serviceable. However, while the FPA, PLI and Stick Shaker are fundamentally attitude based – all take airspeed as an input parameter for validity checking. Boeing cannot guarantee that any of these protective/information systems will function correctly under airspeed unreliable conditions and hence the checklist warns against their use.

In the event of a complete static port blockage, some crew have attempted to depressurise the aircraft/simulator *(Outflow Valves – Manual Override and Open)* to use the pressure sensor in the Cabin Altitude/Pressurisation Controller to indicate ambient altitude *(where EICAS displays Cabin Altitude)*. This technique is technically (systemically) valid and will display an approximate aircraft altitude in a depressurised aircraft – based on standard 1013 QNH.

However, it has been noted that when most crew takeoff with all static ports blocked, adopt the promulgated initial values and commence the NNM – most crew find themselves in excess of 10,000 ft before appropriate pitch/power settings are adopted to obtain level flight. Depressurising the aircraft would result in a ❑ **CABIN ALTITUDE** and a subsequent oxygen/descent scenario. For this reason (and a few others) this technique is not recommended by the Training/Standards Department or Boeing.

Finally – when transitioning from your existing (usually **Too Low** or **Too High**) Pitch Attitude and power setting, give consideration to which one you will action first. For example if you or your autopilot have pitched the aircraft up to 20° chasing a false airspeed indication, your first action might not want to be reducing the thrust back to 85% (and vice versa).

Airspeed Unreliable on Takeoff

An Airspeed Unreliable scenario on Takeoff requires a little more thought than just the Memory Items. If you identify shortly after liftoff that you have unreliable airspeed, adopting the (Flaps Extended) targets of 10° and N1 85%, you may well run into a Flap Limit speed problem. One might ask how you managed to get airborne with this problem when there's a positive airspeed cross check at 80 knots, but **it's happened before** … (Airbus pilots!)

Assuming you maintain your standard pitch attitude ("towards 15 degrees") initially, along with the scheduled takeoff thrust setting, you will eventually be confronted with the following decisions:

- When do I transition to the **Airspeed Unreliable** Memory Items (10°/85%)
- How will I accelerate and clean up without Airspeed – and when (in relation to the Checklist/Memory Items)

Give that some thought now, before you have to solve it in anger in the aircraft (or simulator). Have a look at **Airspeed Unreliable on Takeoff – A Simulator Scenario.**

7.37. NNM VREF & Speed Additives

During training crew often ask if 5 knots is added when using a VREF speed specified by a NNM checklist (such as VREF30 + 30) as is normal practice during NM operations.

Non-Normal Conditions

Occasionally, a non-normal checklist instructs the flight crew to use a VREF speed that also includes a speed additive such as VREF 30 + 20 knots. When VREF has been adjusted by a NNC this becomes the VREF used for landing. This VREF does not include wind additives. For example, if a non-normal checklist specifies "Use flaps 20 and VREF 30 + 20 knots for landing", the flight crew would select flaps 20 as the landing flaps and look up the VREF 30 speed in the FMC or QRH and add 20 knots to that speed.

The FCTM is clear on this, 5 knots **is** added, as are corrections for steady/gusting headwinds during manual thrust or 10 knots for manual landings with auto throttle engaged in high or gusting wind conditions.

7.38. Airspeed Unreliable on Takeoff – A Simulator Scenario

First – go look at **Airspeed Unreliable** ... now read on. Note that all through the following you are **Raw Data, Manual Thrust**. As such while the PF's flying skills are crucial in this exercise – the PM role becomes incredibly important. Captains, once the situation is stable – time to Manage the situation from the PM role (*if you aren't already*).

The following is a suggested technique for dealing with this Simulator chestnut. It involves being ready for the failure before you go, knowing that it's coming and having a plan ready in place - which as an Instructor/Examiner I both applaud and discourage ...

Transition after Takeoff

4 Set the following gear up pitch attitude and thrust:
Flaps extended . . . . . 10 degrees and 85% N1

With the onset of this problem on takeoff – you (*and the AFDS*) are liable to either pitch up or down away from the desired takeoff pitch until the NNM is recognised (*and confirmed*). Having identified things are going pear shaped – you have a choice between returning to the known, familiar pitch setting of Takeoff (*about 13°?*) or transitioning straight to the QRH Airspeed Unreliable values. If you're above 1000 ft AGL and confident of terrain clearance – the QRH should be ok. If you have any terrain concerns, then I would recommend increasing to full thrust and pitching to 15° until clear of terrain and ready to transition to the QRH (or 5,000 ft figures – see below).

Level Off at 5000 Feet

Terrain Area (5000 FT)
Set Thrust for Level Flight

FLAP POSITION (VREF + INCREMENT)		WEIGHT (1000 KG) 210	260	310	360
FLAPS 5	**PITCH ATT**	**6.0**	**6.5**	**6.5**	**6.5**
GEAR UP	%N1	54.3	59.8	64.5	68.9
(VREF30+40)	KIAS	177	192	208	224
FLAPS 15	**PITCH ATT**	**6.5**	**7.0**	**7.0**	**7.0**
GEAR UP	%N1	55.6	61.5	66.3	70.9
(VREF30+20)	KIAS	157	172	188	204
FLAPS 20	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**5.5**
GEAR DOWN	%N1	61.7	67.8	73.2	77.9
(VREF30+20)	KIAS	157	172	188	204

Basically, know your Terminal (*target*) Pitch, Power and Speed for the Weight/Flap you are taking off with. Simple enough?

You'll note here in the QRH PI table that for most of the weights you're going to see (260 to 360 tons), the pitch attitude is the consistent for Flap (6.5°/7.0°/5.5°). Unfortunately, since you'll almost certainly be selecting whatever pitch attitude gives you level flight, this won't help as much as you'd think.

It's all about Thrust; and for a Flap 5 Takeoff, ballpark N1's are for

260T → 60% (192 kts); 310T → 65% (208 kts); 360T → 70% (224 kts)

So, after the initial recognition and adoption of the **Flaps Extended ... Pitch 10°/N1 85%** memory items – level off at 5000 feet on your altimeter, setting the power required from the QRH (*by memory*) and check your pitch attitude for level flight is in the ballpark of what you'd expect. If you've also lost altitude indication bonus points if you remembered the pitch attitude as well, because you'll need it. Note that Boeing only provide Flap 20, **Gear Down**. If you're taking off with Flap 20 when you level the gear will be up, so you'll have to fudge a bit. The Gear UP / Flap 15 figures will be close ... or you could select Flap 15 once you are confident you are at least the minimum speed.

Now wait until you get to the point in the checklist where you are required to verify the QRH Figures against the available air speeds (PFD L / PFD R / ISFD) – and do so.

Assuming you've actually lost all airspeed indications - having stabilised at 5000 ft at basically something just above the minimum speed for your takeoff flap setting (VREF30 +20/40/60), <u>note your ground speed</u>. In the sim, for as long as your headed in a constant direction, this ground speed equates to your required IAS. Gotta love the stability of the sim environment ...

By adding 20 knots at a time you can work your way from the takeoff Flap 20 through to Flap 5, Flap 1 and then UP, 20 knots at a time, +60 knots over all. While the checklist calls for Alternate Flaps as part of the Approach Checklist - I don't see any reason why you can't raise the flap using the normal system, that is if you really feel the need to raise the flap at all - are you thinking of going somewhere?

Flap Maneuver Speeds

Flap Position	All Weights
Flaps UP	VREF 30 + 80
Flaps 1	VREF 30 + 60
Flaps 5	VREF 30 + 40
Flaps 15	VREF 30 + 20
Flaps 20	VREF 30 + 20
Flaps 25	VREF 25
Flaps 30	VREF 30

Configuring for Approach

Having stabilised at clean speed, level flight – by subtracting 60 knots (20 at a time) you can work your way from Up to Flap 1, then Flap 5, and Gear Down Flap 20 for Landing. Do this manoeuvre on a constant heading - which should mean your reference ground speed will hold a pretty consistent relationship to your IAS for the Flap extension and deceleration sequence.

The **Airspeed Unreliable** checklist calls for the use of Alternate Flaps (*electrical extension*) which brings with it the following requirements.

- Extension will be much slower (see **Flaps/Slat Problems & Slower Deployment**)
- You should not reduce speed below the current Flap Minimum speed until the next Flap setting is established (see **Flaps/Slat Problems & Speed Reduction**)
- Landing Flaps will be Flap 20 – and for Go-Around, stay at Flap 20.

Approach Checklist

Alternate flaps extension

ALTN FLAPS ARM switch . . . . ALTN
Alternate flaps selector . . . . EXT
Do **not** accomplish the following checklist:
FLAP/SLAT CONTROL

Remember that if you change direction (*and therefore the relationship between IAS/TAS/Wind Vector/Ground Speed*) you need to stabilise again with a power setting that you are confident gives you the right speed for your configuration - check your ground speed, and start again. Twenty Knots at a time.

Final Approach

The above procedure should get you Gear Down, Flap 20. Complete this well before seeking to establish your final approach path. You should be at or below Max Landing Weight – if not, you're on your own! As you approach the glidepath and establish the descent, you transition from the N1 you were using to maintain your Gear Down / Flap 20 Speed to the QRH Approach (*Gear Down Flap 20*) N1 setting.

Final Approach (1500 FT)
Gear Down, Set Thrust for 3° Glideslope

FLAP POSITION (VREF + INCREMENT)		WEIGHT 210	WEIGHT 260
FLAPS 20 (VREF20+10)	**PITCH ATT**	**1.0**	**1.5**
	%N1	42.4	46.8
	KIAS	164	181

Continue to monitor with ground speed. Your friend the constant ground speed/IAS relationship now varies with descent as TAS reduces to IAS; and wind backs towards the value report on the ground. The closer you get to the ground, the closer you get to a known headwind component – know in advance what kind of headwind you're expecting late on approach, and therefore the ground speed you expect to see for your chosen Attitude/Power/IAS.

Go-Around

So, the first thing is – don't. Tell ATC you require priority. Establish final fully configured. Tell your Sim Instructor, "**No Thanks.**"

The QRH PI includes Pitch Attitudes for go-around that can take you as high as 23°. Even at 250 tons - the recommended pitch attitude is 18°. If this sounds high to you, you're not alone. The figures are of course not wrong, and targeting them is "normal".

Go-Around
Flaps 20, Gear Up, Set Go-Around Thrust

PRESSURE ALTITUDE		WEIGHT 210	WEIGHT 260
5000	**PITCH ATT**	**19.5**	**16.0**
	V/S (FT/MIN)	4400	3400
	KIAS	157	172
SEA LEVEL	**PITCH ATT**	**23.0**	**18.5**
	V/S (FT/MIN)	5100	4100
	KIAS	157	172

If you were to encounter Airspeed Unreliable on approach and conduct a go-around without reference to the QRH - the FCTM recommends 15°. In all likelihood this will mean some measure of acceleration during your climb out, which I guess we can live with. After 20 years on the 777 I get a nose bleed above 15° of pitch anyway ... unless there's a hill in the way. As such I figure I can survive a go-around without going all the way to 23° of pitch up. And of course – don't use the TO/GA switches.

Once again - after a go-around, climbing to a (QRH PI) known altitude such as 5000 and setting a power from the book makes your life just that much easier. Raising the gear in the go-around is standard – but leave the Flap at 20. As before, the QRH doesn't have a Pitch/Power and Flap 20 speed at 5000 ft with the Gear Up. But it does have Flap 15 - so either tweak and use that; raise the Flaps to 15 - or I supposed you could lower the gear!

Terminal Area (5000 FT)
Set Thrust for Level Flight

FLAP POSITION (VREF + INCREMENT)		WEIGHT 210	WEIGHT 260
FLAPS 15 GEAR UP (VREF30+20)	**PITCH ATT**	**6.5**	**7.0**
	%N1	55.6	61.5
	KIAS	157	172
FLAPS 20 GEAR DOWN (VREF30+20)	**PITCH ATT**	**5.0**	**5.5**
	%N1	61.7	67.8
	KIAS	157	172

Summary

The above is a suggested technique for dealing with a very much canned scenario in the sim that quite often goes badly. It assumes you know the event is going to happen, or at least things that it's likely enough that you're willing to expend the time and effort preparing specific mitigation against it. We do that for a lot of other events, why not this one …

7.39. AUTOSTART Checklist – where did the message go?

The Autostart NNM is one area where the EICAS does not appear to work as advertised – but where applying the philosophy of EICAS/ECL usage brings about the correct result.

In the event of an EICAS ❑ AUTOSTART L/R during engine start, PF will action the Memory Items associated with the associated NNM checklist (**Fuel Control Switch … Cutoff)**. Because the engine is now in Cutoff (*and on the ground*) most associated non-normal engine messages are inhibited – include ❑ AUTOSTART. But the PF who has read his Boeing documentation will know that once NNM Checklist Memory Items are called for, the next action is to call for the associated checklist. When the EFIS Checklist button is pressed – the ❑ AUTOSTART Checklist is in the ECL NNM Queue – ready to action.

The introduction of the ❑ CHKL NON-NORMAL has helped this somewhat – see EICAS ❑ CHKL NON-NORMAL.

7.40. Single Source Displays

The ❑ SGL SOURCE DISPLAYS failure can manifest in different ways in the aircraft depending on the specifics of the failure. In our simulator, this programmed failure is severe, with the following features:

- Captain's PFD mirrored onto the First Officer's PFD
- Captain's ND mirrored onto the First Officer's ND
- Upper EICAS functional
- Lower MFD not functional

> **[] SGL SOURCE DISPLAYS**
>
> Condition: Some or all display units use a single source of display data.
>
> **Note:** Both PFDs and NDs or just both NDs show information generated from a single source. The lower center display unit may be blank or may not be capable of showing all normal formats. The left EFIS control panel controls either the right PFD and ND or the right ND only.

Not surprisingly – this has some implications. Typically, ❑ SGL SOURCE DISPLAYS is used by examiners during a check sequence to force a downgrade/go-around from a Cat 2/3 approach. Because the training/checking sequence usually calls for a repeat Cat 2/3 approach and landing, the failure is then cleared prior to a reposition/vector for a subsequent Autoland. This means crew can say they have seen the failure – but often the implications of flight management – particularly in relation to monitoring and checklists – have been missed. Consider the following:

- All selections on the Captain's PFD/ND will be mirrored across to the First Officer's PFD/ND. This means Minima Settings, Altimeter Settings, all MCP selections, ND Mode/Range Settings, Weather Radar, Terrain, etc. For example – Captain can use WXR or TERR, but not both; and the First Officer will see those selections on the onside ND. In effect the First Officer's EFIS Control Panel is all but useless.
- ECL is functional but the lower MFD is not. Therefore, the ECL must be run on the ND. However, there is only one functional ND – the Captain's. Therefore, the Captain must not only display the ECL on that side ND (*and it will be repeated on the First Officer's ND*); additionally, the only cursor access to the ECL is through the Captain's CCD. In effect, to use the ECL the Captain must become PM and there will be no ND available during ECL use.

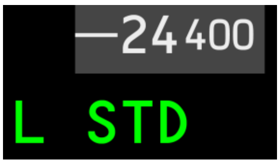
There are clearly other impacts of this significant, systemic failure to the flight instruments/displays system, but the impact to the ECL is significant. Refer to Dispatch without ECL for a discussion of operating without ECL.

The aircraft still has the capability of a Cat 1 Approach, or an RNAV GNSS (not RNP AR). A discussion should ensure about who flies – remember all EFIS control panel selections will need to be made on the Captain's side and will display identically on both PFD/ND's. Reversion to paper normal checklist is possibly a better course of action.

7.41. Rapid Descent and Transition Altitude

The high rate of descent established in the event of cabin depressurisation occasionally results in a capture of an altitude prior to the crew setting QNH – particularly when Transition Level is near the initial Level Off Altitude, (*eg: FL110 vs 10,000 ft*).

If the AFDS captures the MCP Altitude setting prior to the crew setting QNH, resetting QNH after the **ALT** capture will not update the AFDS – the aircraft will level at FL100 on Standard. If this occurs, the simplest recovery technique is to ensure QNH is set, then re-select Flight Level Change (**FLCH SPD**). The AFDS will update the target altitude and re-acquire your desired level off altitude. One way to avoid this is to call "**Transition**" a little early to ensure altitude capture occurs on QNH – a reasonable rule of thumb using the rate of descent seems to work, so if you're descending at 3000 fpm, call transition 3000 ft early.



In particular for single pilot operations, the PF must remember that the AFDS looks at the L/R EFIS panel for QNH/STD altimeter setting (*and minima callout*) as indicated on the PFD. When you are single pilot PF in the right-hand seat – if the source indication on the PFD is "**L**" – even though you have gone QNH on your side, the AFDS will level off at the MCP altitude based on the Left EFIS Control Panel altimeter setting – which is usually still on Standard. As such, when you set your RHS EFIS panel to STD, you will have to reach across and set the other EFIS control panel to STD if the "**L**" is indicated on the PFD.

7.42. Dual (R+C) Hydraulic Failure & The Stabilizer Memory Items

Another system failure with a catch is the Hydraulic Pressure System Right and Center failure. This results in no hydraulic pressure to the Stabilizer which is therefore inoperative, and so ❑ **HYD PRESS SYS R+C** checklist incorporates all the items of the Stabilizer checklist, and in fact inhibits the "❑" icon for the **STABILIZER** checklist (*but not the EICAS message*).

However, if the Stabilizer should attempt to move (*change in airspeed, altitude, configuration, etc*) before you get to the Stabilizer Cutout switches in the Hydraulic failure checklist, then the **STABILIZER** warning will be raised by the EICAS. The **STABILIZER** checklist has Memory Items – but you are in the middle of a Caution level NNM checklist – what do you do?

Airmanship (*and your Boeing QRH*) requires you to action the higher priority item – ❑ **STABILIZER** checklist Memory Items (**STAB Cutout Switches (both) … CUTOUT**, and **Do not exceed the current airspeed.**) ... "**… Memory Items Complete.**"

The question is – what do you do now? Boeing advises that a checklist with Memory Items has higher priority than a checklist associated with a Caution (**Prioritisation of NNM Checklists**) and so technically you should action the **STABILIZER** checklist.

Before continuing this discussion, let it be said that if the ❑ **STABILIZER** checklist **is** called for and actioned– in accordance with EICAS/ECL philosophy – there is no negative flight safety impact.

However – because the ❑ **HYD PRESS SYS R+C** checklist has begun – the checklist for **STABILIZER** is now already inhibited. **STABILIZER** appears on EICAS without the checklist icon (❑), it will not be in the ECL NNM queue and therefore you would have to hunt through the ECL NON-NORMAL MENU. From these indicators it could be said that the Hydraulic Pressure System R+C checklist can be continued instead.

Again, if you haven't taken the hint(s) and doggedly bring up and complete the **STABILIZER** checklist – there is no negative flight safety impact. The design of the EICAS/ECL integration protects the conscientious as well as the casual.

Finally – it's worth appreciating that if the ❑ **HYD PRESS SYS R+C** checklist had <u>not</u> been opened by the crew – the ❑ **STABLIZER** message would retain the checklist icon (❑) next to it. The action of inhibiting a checklist is not taken by EICAS/ECL until the checklist that causes the inhibit has been opened by the crew on the ECL.

7.43. Altitude Selector and Engine Out Drift Down Descents

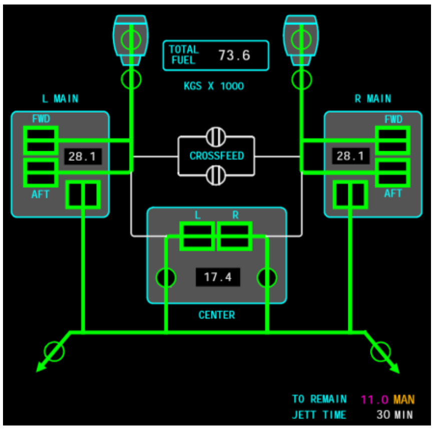
The question often arises whether you should press the altitude selector during the commencement of an Engine Out Drift Down descent. Firstly – go back and read the paragraph **Keep pressing that Altitude Selector … NOT**

If the standard procedure has been followed to commence an engine out descent in VNAV, there are now three (*perhaps four*) reasons to use the altitude selector.

- The FMA is in **VNAV ALT** (*Either it was VNAV ALT before the engine failure, or the altitude selector was not reset to the preferred engine out level off altitude when the EXEC button was pressed*) – Pressing the altitude selector <u>once</u> will commence the Engine Out Drift Down once the MCP Altitude is set correctly.
- The Altitude selector is set to a different altitude (*usually a quadrantile level*) to the FMC Engine Out Cruise Altitude and PF needs to update the FMC Cruise Altitude to match the MCP selected altitude – pressing the Altitude Selector achieves this.
- Potentially, if the aircraft was near top of descent AND there was an altitude restriction on the legs page above the new Engine Out Cruise Altitude, the altitude selector may be required to clear that restriction.

Note that pressing the altitude selector during an engine out drift down unnecessarily can result in the FMC transitioning from an engine out drift down into a cruise descent of 1250 fpm, or a standard idle thrust descent, or another beer to the Training Captain on your tab.

7.44. Fuel Jettison & Fuel Imbalance



After the loss of an engine at heavy weight, crews will usually be confronted with the EICAS ❑ FUEL IMBALANCE advisory, having already commenced the ❑ FUEL JETTISON checklist to reduce weight for landing. The fuel imbalance commences immediately, since (*depending on Fuel Quantity/CoG*) Fuel Jettison commences from the all tanks, while one engine feeds off the Main Tank. While nominally the Center and Main Tank Jettison Pumps are the same (*at three times the output pressure of the Main Tank Fuel Pumps*); in the real world there will be differences due to manufacturing tolerances.

In at least one real-world event this disparity in output between two main tank Jettison Pumps resulted in an EICAS ❑ FUEL IMBALANCE advisory during a two-engine return to departure airport. Another factor can be the inhibition of the Main Tank Jettison Pumps when the system detects a forward centre of gravity problem. At this point the Center Tank Jettison Pumps can override the Main Tank Fuel Pumps – and feed the engine(s) as well as the jettison manifold.

The FCOM/FCTM contains no limitation on simultaneously running both procedures. The ❑ FUEL IMBALANCE message itself is not inhibited during fuel jettison. Instinctively many Captains are distrustful of running two fuel NNM's at the same time – perhaps for good reason (*many of them have flown Airbus*).

Boeing have stated that the primary intent of the fuel imbalance AFM limitation is "***long term structural (airframe/landing gear) fatigue levels***". The alert is timed to precede the AFM limitation to give the crew time to respond. Boeing have also stated that "***lateral control is not significantly affected when operating with fuel beyond normal balance limits – but an increase in trim drag and higher fuel consumption can be expected.***" Boeing has also suggested completing the Fuel Jettison prior to commencing the Fuel Imbalance Checklist (*time permitting*).

The issue of the need to combine fuel jettison with the fuel balancing procedure is rarely encountered in the simulator, **in spite of the fact that it should be a common event**. While Jettison may commence normally, it's often expedited to the Fuel-To-Remain figure by the Instructor – a process which automatically balances the fuel load. This Simulator process typically empties the Center Tank and establish the Fuel-To-Remain fuel quantity in both Main Tanks – **this is also a false result as a standard Fuel Jettison empties fuel from all tanks simultaneously; as such crew can expect in the real world the Fuel-To-Remain to be spread across all three fuel tanks, depending on initial fuel quantity and other factors.**

Often the unwanted fuel is dumped by the instructor without use of the jettison system at all, once the crew identify the heavy aircraft weight. With fuel jettison from maximum takeoff weight to maximum landing weight taking over 40 minutes, instructor intervention to expedite is not surprising.

In fact, the question is **not** "*Should you run the Fuel Imbalance Checklist while engaged in Fuel Jettison?*" but in fact "**Should you choose NOT to run the Fuel Imbalance Checklist during Fuel Jettison?**"

> Fuel imbalance between main tanks for taxi, takeoff and landing must not exceed:
> - 3000 lb (1360 kg) when total main tank fuel exceeds 123,000 lb (55,791 kg).
> - 4500 lb (2041 kg) when total main tank fuel is less than or equal to 90,000 lb (40,823 kg).
>
> A linear interpolation between 4500 lb (2041 kg) and 3000 lb (1360 kg) when main tank fuel is greater than 90,000 lb (40,823 kg) and less than or equal to 123,000 lb (55,791 kg), respectively.

Choosing NOT to run a NNM checklist is always within the purview of the Captain – but the implications of not running that checklist should be mitigated (see **How NOT to do a Checklist**)

If the crew choose not to run the ❑ FUEL IMBALANCE checklist, then potentially they could be accepting a significant fuel imbalance by the time the jettison stops, with fuel as low as the Main Tank Standpipe level (*see FCOM*) in the Main Tank providing fuel to the remaining engine. Potentially the ❑ **Overweight Landing** checklist will still be required, as the ❑ FUEL JETTISON MAIN system failure occurs when fuel in one of the main tanks reaches jettison standpipe level (5.2 tons) before the fuel jettison target fuel load is reached. Again (from Boeing) – this is acceptable, if disconcerting.

A Captain can always choose not to do, or to halt a NNM checklist. In this case the best method may be to commence the Fuel Imbalance checklist, verifying there is no fuel leak, then halt the checklist prior to the commencement of the actual fuel balance procedure. Complete the fuel jettison, then return to the Fuel Imbalance checklist and proceed.

That said the Fuel Imbalance checklist works well enough during fuel jettison – at least as long as nothing else goes wrong. The main tank jettison pumps take no part in the balancing of fuel, they feed into a separate manifold. As long as the jettison nozzles are open, fuel from the centre tank takes the path of least resistance out the jettison valves. When jettison is complete the pumps cease and the centre tank isolation valves are closed automatically. Meanwhile the operating engine balances fuel.

The point of this section is to explain the issues associated with Fuel Imbalance combined with Fuel Jettison – and to point out that this is another of those times where if the crew chooses NOT to do something – it should be NOT done, properly.

7.45. Landing with a Fuel Imbalance

In practice, there is no restriction on commencing/continuing an Approach and Landing while balancing fuel with the Fuel Imbalance checklist in progress. Indeed, this is to be expected when balancing fuel prior to approach. This is however one of the very few times when a NNM checklist is <u>not</u> completed prior to landing.

BOEING
777
AIRPLANE FLIGHT MANUAL

CERTIFICATE
LIMITATIONS

<u>F U E L   S Y S T E M</u>

<u>USABLE FUEL TANK QUANTITIES</u>

<u>FUEL LOADING</u>

Fuel imbalance between main tanks for taxi, takeoff and landing must not exceed:

3000 lb (1360 kg) when total main tank fuel exceeds 123,000 lb (55,791 kg).

4500 lb (2041 kg) when total main tank fuel is less than or equal to 90,000 lb (40,823 kg).

A linear interpolation between 4500 lb (2041 kg) and 3000 lb (1360 kg) when main tank fuel is greater than 90,000 lb (40,823 kg) and less than or equal to 123,000 lb (55,791 kg), respectively.

It's worth noting that the AFM contains limitations on Fuel Imbalance dependant on total fuel quantity. These certified limitations on takeoff and landing with a fuel imbalance are not required knowledge (*and therefore not included in the FCOM*) because Boeing have taken steps to ensure crew deal appropriately with a Fuel Imbalance limitation exceedance – by prompting the crew through EICAS for the Fuel Imbalance checklist. Thus, crew who ignore the Fuel Imbalance checklist "***It's not a Leak***"; "***It's not a limitation***" are in fact not responding appropriately.

The AFM Fuel Limitations are about long-term structural life of the aircraft and landing gear. Lateral control of the aircraft is not significantly affected by fuel imbalance in excess of AFM limitations – although increases in drag and fuel flow can result.

For all that – the limitation remains, and common practice remains <u>not</u> to delay a landing in favour of waiting for any imbalance to reduce down below AFM limitations.

Of course, the Captain can always elect to delay initiation or halt completion of the Fuel Imbalance checklist when commencing the approach/landing (*or something else*) is the higher priority for flight safety. See **How NOT to do a Checklist** for a discussion of this issue and Fuel Imbalance specifically.

Note that Stabilisation Criteria (1000 ft AAL) usually includes the requirement to have completed all "Normal" checklists …

7.46. Single Pilot NNM's in Cruise – the Other Pilot

Something that's been noticed for NNM's given to pilots in cruise when they're single pilot ("***Geoff has now gone back to take care of a biological need …***") is a certain reticence to call that pilot back in the event of a NNM, or at least some confusion over when that action should be taken. At least in part, this is a simulator issue. Let's look at a typical NNM and review when it's a good time to call back the other pilot. Cross reference with **Non Normal Management Model ANC-AAM** here.

<u>Generic NNM Handling</u>

- **Fly The Aircraft** !
- Call/Assess the Failure .... Done
- ATC Call?..................... As Required
- Failure Assessment ..... As Required
- Checklist Memory Items .... Done

---- Call the PM / Captain / Crew? ----

- Mini Plan ....Consider
- NNM Checklist ....Complete
- NM Checklist................ As Required
- Diversion Plan....................Consider

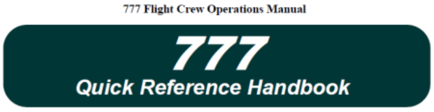
In essence, it's expected that the Aviate/Navigate/Communicate components are completed by the single pilot to ensure aircraft control is maintained.

At some point a failure assessment (*perhaps as simple as reading the EICAS*) needs to commence, which could include an engine failure assessment (see **Engine Failure Analysis**). This would promptly be followed (*or even preceded*) by the commencement of a drift down in the event of an engine malfunction if the aircraft is above engine out maximum altitude. Once flightpath is established – checklist memory items should be completed if not already.

At this point, with the aircraft safe, the memory items complete – this is a good time to consider calling back the other pilot. It may well be at this point that you have enough information to call back the crew in rest as well.

It's typically less than ideal – and usually unnecessary – to start the NNM checklist. Even in the event of a Limit/Surge/Stall and an engine misbehaving at idle, it's usually better to wait and action the checklist – which will include shutting an engine down, choosing a flap setting for landing, etc – as a two-pilot activity.

7.47. Dispatch without ECL



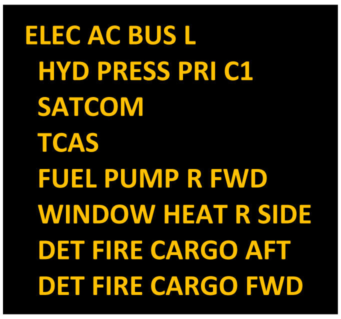
When the Electronic Checklist is failed or disabled ...

- EICAS does not display checklist icons (❑) beside alert messages.
- Crew are required to use the paper checklist in the QRH for Normal and Non-Normal checklists.
- When the QRH inhibits a checklist ("**Do not accomplish the following checklists:**") this needs to be noted down by the crew for the follow up EICAS Review.
- When a QRH NNM references a Note (such as "**Note: Use Flap 20 and ...**") these need to be collected by the crew - either written down or ideally the page in the QRH marked for later reference.
- Note that pressing the CHKL switch displays a **CHECKLIST DISABLED** message on the MFD.

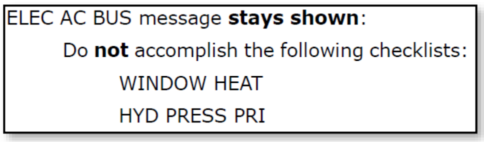
In the event of a significant failure with multiple EICAS Alerts, crew will need to prioritise the messages using **Warning**/**Caution**/_**Advisory** status without the assistance of checklist icons on EICAS. For each message, the QRH will need to be consulted to see if there is a NNM checklist associated with the alert, unless a previous checklist has advised "**Do not accomplish ...**".

The **CHKL** -> **CHECKLIST DISABLED** feature can be used to reduce the chance of forgetting a NM checklist. The PM should still press the CHKL button as part of the standard flows (*see below*), and the **CHECKLIST DISABLED** message serves as a prompt for the need to accomplish a NM checklist. Similarly, when a NNM checklist is held (*eg: during Fuel Jettison*) the CHKL -> CHECKLIST DISABLED could be used to remind the crew of an outstanding NNM.

- End of **Before Start Flow** (Before Start Checklist)
- End of **After Start Flow** (After Start Checklist)
- End of **Departure Review** (Before Takeoff Checklist)
- Flaps UP after takeoff (After Takeoff Checklist)
- Gear Down/Flap 20 (Before Landing Checklist)
- End of **After Landing Flow** (After Landing Checklist)
- Fuel Jettison "**When** fuel Jettison is complete ..."
- Fuel Imbalance "**When** fuel balancing is complete ..."



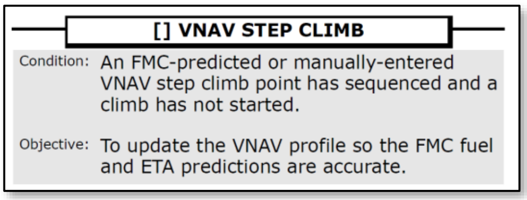
After extended use with ECL, using a paper checklist requires a set of CRM and NNM management skills that may well be rusty in line crew. **Crew need to work methodically through NNM's and care taken to ensure NM checklists are remembered and actioned.**



The paper QRH is designed to account for the accumulation of Notes and Deferred Checklists into the Approach and Landing Checklists. However as soon as you combine two or more NNM's that have such requirements – all bets are off and it's down to the crew to collect and apply the requirements from multiple checklists. Remember – this is a Boeing, and by design – you're not supposed to have more than one thing wrong at a time ...

It's easy to become confused between the notes of the QRH vs the displayed EICAS messages – especially since the single QRH checklist covers both (Left) and (R)ight versions of a a variety of single failures.

7.48. EICAS VNAV STEP CLIMB Message



Another message elevated by Boeing from FMC Scratchpad to EICAS Alert status is the ❑ **VNAV STEP CLIMB** alert, indicating that the aircraft has flown past the point that a climb to the next step altitude is recommended.

Once again – it's an EICAS NNM alert, and the impetus is often to bring up the checklist and head down the rabbit hole, but a valid alternative is to solve the actual problem causing the alert.

- Move the Step further down route on the CDU LEGS page – such as at the next FIR boundary (eg /330S);
- Increase the Ste size back to RVSM to delay the step;
- Call ATC and request the climb.

There shouldn't be any reason why the checklist can't be delayed (*leave the alert message on EICAS*) while you sort out the step climb issues.

7.49. ENG OIL PRESS – A Sim Scenario

[] ENG OIL PRESS L, R	
Condition: The engine oil pressure is low.	
1	A/T ARM switch (affected side) . . . . . Confirm. . . . . OFF
2	Thrust lever (affected side) . . . . . Confirm. . . . . Idle
3	FUEL CONTROL switch (affected side) . . . . . Confirm. . . . .CUTOFF
4	APU selector (if APU available) . . . . START, then ON
5	Transponder mode selector . . . . . . TA ONLY
6	Plan to land at the nearest suitable airport.

This failure seems simple enough – one of the engines is low on oil pressure; the checklist reduces thrust and shuts down the engine.

Then there's the reality of dealing with an engine NNM under various conditions of high altitude and high thrust settings, etc.

In the simulator this failure is typically given at high altitude to add the complication of the requirement for an engine out drift down. Thus, the PF needs to decide between running the checklist, or commencing a drift down in anticipation of the thrust loss – or both. The determining factor is usually the margin above minimum manoeuvring speed – it's a judgement call by the PF/Captain.

Alternatively, it's given during climb with high thrust set on both engines. This reduces significantly the time before the onset of engine failure indications including further limit exceedances, engine/airframe vibration and more severe damage. You can't run an engine for very long without oil pressure and the more thrust you ask of it, the shorter that time period is.

It should be noted that in the circumstance where the engine fails or otherwise malfunctions as a result of running too long without oil pressure - one of the Engine Failure checklists (*along with any associated memory items*) is usually a more appropriate response to the failure than the annunciated ❑ ENG OIL PRESS checklist.

In the simulator, the time between the EICAS message and the onset of engine damage is pretty dependent on thrust on the engine and is essentially formulaic – driven by simulator programming. If the failure occurs in the climb and climb thrust remains set – engine failure with the potential for engine damage comes soon(er). Again - once the engine indicates the conditions for ❑ ENG FAIL, ❑ **Eng Lim/Surge/Stall** or ❑ **Eng Svr Damage/Sep**, the PF should commence an Analysis (**Engine Failure Analysis**) and commence any applicable memory items. Don't forget to Fly The Plane.

It's not unusual for the crew when first given this failure to be slow in actioning the checklist, and the engine fails with associated limit exceedance / damage indications. The crew's reaction to this experience, combined with some (perhaps) inappropriate debriefing by the instructor leads to some inventive responses from both trainees and instructors alike during follow up encounters. This usually takes the form of:

- Calling for the ❑ **Eng Lim/Surge/Stall** checklist memory items. Since low engine oil pressure shows a limit exceedance, this would seem a possibly logical response. Having run the memory items – in which case the appropriate follow on would be the Engine Limit/Surge/Stall checklist rather than the annunciated Oil Pressure checklist (*although attempting a re-start of the engine may not be advisable.*) Note however that these memory items only reduce thrust on the engine and it's the checklist that actually shuts it down precluding further damage. Thus, the memory items will only delay the onset of engine damage. Therefore, the following action is often seen in the simulator …
- Calling by memory for the Fuel Control Switch to Cutoff. Some instructors will frown upon this action, but it's a legitimate call by the Captain on the day to make. This combination of Engine Limit/Surge/Stall and Fuel Control Switch secures the engine and prevents (further) engine damage when for some reason responding directly to the ❑ ENG OIL PRESS is not preferred.

The above is however a fairly complex response to a simple loss of oil pressure. It's hopefully fair enough to say that the simplest response is probably to (a) fly the aircraft; and (b) run the checklist. If the aircraft is in a high thrust situation this can often be relieved quickly by the PF through levelling off and slowing down – without the need for running checklist memory items or checklist items by memory. Levelling off and slowing down (*where possible*) usually achieves the aim of reducing thrust on the affected engine enough to give you time to complete the ❑ ENG OIL PRESS checklist (*at least to* ***Fuel Control Switch … Cutoff***) prior to engine damage.

7.50. FLAPS DRIVE – Where Are The Flaps?

[] FLAPS DRIVE

Condition: The flap drive mechanism is failed.

1 Do not use alternate flaps. Asymmetry and uncommanded motion protection is not provided in the alternate mode.

2 GND PROX FLAP OVRD switch . . . . .OVRD

Note: Do not use FMC fuel predictions with flaps extended.

3 Choose one:

◆Flap position is **5 or less**

Note: Move the FLAP lever to 1 and use VREF 30 + 40 for landing. This ensures the slats are extended.

►►**Go to step 4**

◆Flap position is **between 5 and 20**

Note: Use current flaps and VREF 30 + 20 for landing.

►►**Go to step 4**

◆Flap position is **20 or greater**

Note: Use current flaps and VREF 20 for landing.

►►**Go to step 4**

In the event of a ❑ FLAPS DRIVE failure, the checklist asks the crew to confirm the position of the Flaps. This sounds simple, but can be made complex by the situation ... and the crew ...

Flaps Drive is the response of the FSEU to either a failure of the flap extension system – or the detection of flap asymmetry. Typically, the FSEU doesn't act to ***prevent*** the commencement of an asymmetry – it acts to ***contain*** the increase of a detected asymmetric condition.

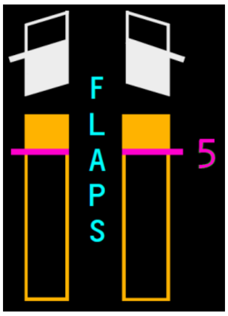
Asymmetry can be caused by either:

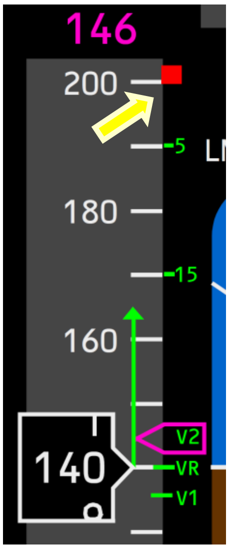
- Failure of the flaps to respond to a command to move (*or move in the right direction*); or
- Failure of the flaps to respond to a command to stop moving.

When asked to look at the position of the Flaps, crew have several things they could consider:

- Expanded EICAS Flap Position indicator (*Primary*);
- Flap Lever position (*combined with where the lever was before the failure occurred, assuming the failure occurred as the result of pilot command*);
- PFD Flap Speed Limit indication.

This last one bears a little discussion. The speed limit indication markings on the PFD (*red square dots at the top of the speed tape*) indicate the flap limit speed for the current flap position (*not current flap selection*). The sensors for the left and right PFD indication limit speed detections take their inputs from different flaps; hence it's possible (*likely*) during a Flaps Drive failure to have two <u>different</u> speed limit indications. Thus, the (*two*) PFD speed limit(*s*) can be another indication of Flap position(*s*).





Question : Which indicated speed limit should you respect?
Answer : Both of them, of course.

Question : Which one will the AFDS respect? Oooh – Good Question.
Answer : Usually the one that is powering the AFDS Barometric Source (see FCOM "Autopilot/Flight Director Barometric Source")

<u>Scenario</u> : Takeoff at Flap 15, Failure occurs during retraction to Flap 5. Where are the Flaps?

A good look at the expanded Flap Indicator gives the information required.

Magenta "5" indicates the commanded flap position by the flap lever is Flap 5 – the magenta colour indicates that the flaps are NOT at 5. If the flaps were detected at commanded position, the indication would be green. Amber indication reflects the existence of the current Flaps Drive failure. The Flaps aren't going anywhere.

During takeoff, the Flap Lever was at 15, and now it's at 5. Therefore, the flaps should somewhere between 15 and 5. Unless ... If the failure was ***uncommanded movement*** – that is, the flaps were retracted to 5 and one of the flaps failed to respond to the command to ***stop*** moving – where would that flap be now? Would this flap position at less than 5 be indicated on the expanded display?

Or what about if the command to ***retract*** resulted in an ***extension*** of flap before the FSEU's kicked in? Hmmm. Ok, I may have over-thought this …

Finally – in this particular scenario, one of the PFD speed limits reflects 245 knots (*ignore the picture!*) – Flaps 5; the other reflects a higher speed – Flaps something less than 5.

<u>Solution</u> : Fortunately – the checklist gets by all these possible conundrums (*how very Boeing of it*). The checklist doesn't offer you Flap 5. It says "**5 or less**" and this is the most correct response. Speed selected is based on Flaps Up and you'll fly your approach with the excess speed associated with a midrange slats only extension. The (*probably*) incorrect choice of "**between 5 and 20**" has you on approach assuming Flaps 5, which may be slightly slower than the minimum recommended speed – but it in all likelihood well within the margin of safety.

7.51. Engine Out Drift Down – FMA!

The basic steps to initiate a VNAV engine out drift down are covered during transition and reviewed in line training. However, the following aspects deserves further attention based on observations from recurrent training/checking.

VNAV Engine Out Drift Down

- Fly The Aircraft !
- VNAV ENG OUT > ....Select
- MCP Altitude Selector.................Set
- CDU Modification................. EXEC

Verify

- FMA ....THR LNAV VNAV SPD
- PFD Speed ...ENG OUT D/D Speed
- Thrust Limit ....CON

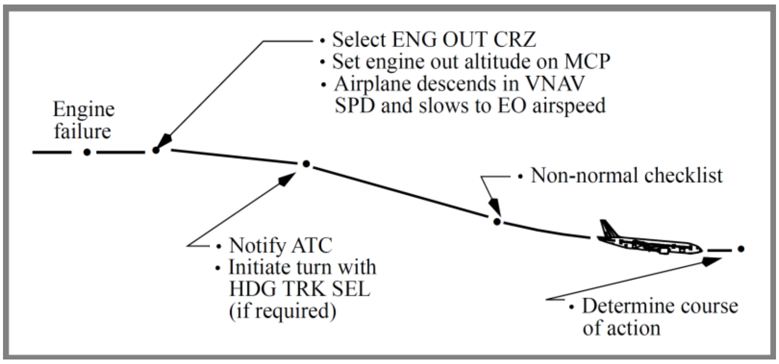
- Pause to ensure you **Fly The Aircraft!** This means positively ensuring pitch attitude, lateral control and thrust. If the TAC has failed rudder input is required although trimming can be delayed if necessary. Ensure the Auto Throttle is advancing thrust on the good engine. Note that verbalising some of this as you do it may feel odd – but it makes the assessment task much easier for your instructor/examiner and keeps the PM in the loop.
- The requirement to move straight into the drift down is usually driven by Airspeed, specifically how long until you're down near the minimum manoeuvre speed. The higher above the engine out maximum altitude the aircraft is, the faster the speed will decay. Drift down is initiated through the CDU by selecting the **VNAV ENG OUT>** line select key.

- The CDU highlights the proposed modifications including an altitude change (*if the ENG OUT max alt is below current aircraft altitude*), and the recommended engine out cruise speed. Either the recommended altitude *(or lower – next quadrantile)* is set in the MCP Altitude Selector.
- At this point the FMC modification can be *(confirmed)* **EXEC**uted.
- It's now **crucial** that the PF verifies the following:
  - ✓ **Verify the required FMA change**. The Autothrottle should be driving to maintain CON thrust (**THR**); and the pitch mode should command the engine out drift down speed (**VNAV SPD**).
  - ✓ Verify the Engine Out Drift Down Speed.
  - ✓ Verify **CON** Thrust Limit Set.

Calling and Verifying the FMC change is crucial. One of the more common errors observed in the simulator is attempting to commence the drift down while not in **VNAV SPD/PTH** – such as **ALT** or **VNAV ALT**. In this case the FMA won't change, the descent won't commence and the speed will decay into the manoeuvre margin, usually as the crew are distracted commencing the NNM checklist.

VNAV Speed or VNAV Path?

In principle, a correctly executed engine out drift down should result in **VNAV SPD** - the elevators are pitching to maintain the engine out drift down speed, even as the thrust levers (**THR**)target **CON** thrust on the serviceable engine. See FTCM CH4 **Engine Inoperative Cruise/Drift Down.**



There are certain circumstances in which the AFDS will transition instead to **VNAV PTH** such as when operating relatively close to engine out maximum altitude and excess airspeed cannot be reduced to achieve the engine out drift down speed – or if the drift down is commenced close to the FMC top of descent point.

7.52. Basic Modes Engine Out Drift Down

There are a couple of reasons why you might find yourself with the requirement to initiate and manage a basic modes engine out drift down from altitude, including a failure of VNAV to behave as expected/required (*or your failure to action the procedure properly*) – but the most common reason is because a ~~Sadist~~ Check Captain asks you to.

Broadly speaking the procedure required falls into one of two possibilities – when the FMC VNAV Cruise page is available; or when it's not. When the FMC is there to give you an altitude and speed to aim for, you set those as part of the procedure shown here. Otherwise initial values of FL150 (*or higher if MSA requires*) and Turbulence Penetration speed are used until these can be refined using the QRH Performance Inflight later on during the drift down.

Once VNAV is out of the picture, there are only two modes available for the descent – VS (FPA) or FLCH. VS would be a high workload solution since fundamentally you want a speed targeting/protecting manoeuvre (*which VS is not*), and without the constant attention of the PF, in VS at high altitudes overspeed / underspeed excursions are a risk. Hence FLCH is the mode of choice for a basic modes drift down.

Basic Modes Engine Out Drift Down

- Fly The Aircraft !
- CDU VNAV ENG OUT > ....Select
- MCP Altitude Selector ....Set
- CDU Modification........................ EXEC
- FLCH ....Select
- Auto Throttle .... Disconnect
- Thrust Levers................. Set CON Thrust
- MCP Speed ....Set ENG OUT Speed

Verify

- FMA .... (Blank) LNAV FLCH SPD
- PFD Speed ....ENG OUT D/D Speed
- Thrust Limit....................................CON

However, since FLCH is an idle thrust mode and you want to minimise the rate of descent, the Autothrottle is disconnected and CON thrust is set manually. This is done using the Thrust Lever Autothrottle Disconnect Switches to leave the Autothrottle armed - not the MCP Autothrottle Arm Switches. Note that the Autothrottle is disconnected after FLCH is selected, since engaging FLCH second would simply re-engage the Autothrottle.

If the engine is actually "failed" (*either EICAS* ❑ ENG FAIL *or the **Fuel Control Switch … Cutoff***) then when FLCH is selected, the CON thrust limit will be set, and the PF moves the thrust levers as required to maintain the CON thrust limit. Otherwise, the CDU THRUST LIM page must be used to select the CON thrust.

7.53. EICAS INSUFFICIENT FUEL Message

There was a time when **INSUFFICIENT FUEL** was an FMC scratchpad message that we never dismissed lightly or without considering the ramifications (see FMC Scratchpad Messages). We did such a good job of that, Boeing decided to upgrade it to a full on EICAS ❑ INSUFFICIENT FUEL alert, generated when the predicted destination arrival fuel (*calculated or if selected, totalizer*) is less than the CDU **PERF INIT RESERVES** figure.

[] INSUFFICIENT FUEL

Condition: FMC estimated fuel at the destination is less than the entered RESERVES fuel.

1 The INSUFFICIENT FUEL message may be caused by a fuel leak.

The checklist is wordy and focusses initially on the old chestnut of determining whether there is a fuel leak. It can be a significant distraction when there actually isn't a low arrival fuel condition affecting the flight.

There are three common causes for this occurrence I'd like to consider:

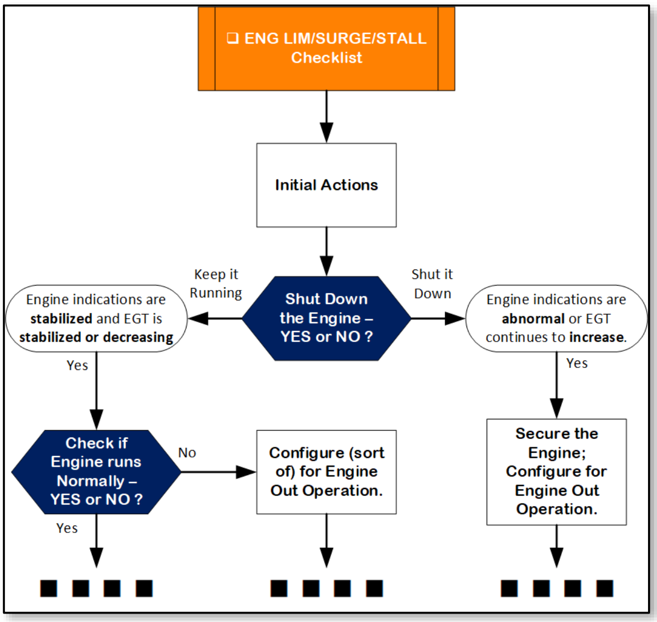
- During FMC changes, particularly changing sectors of the route or arrival – transitory values of low arrival fuel can be generated, resulting in a Scratchpad/EICAS ❑ INSUFFICIENT FUEL that quickly resolves once the FMC settles down and calculates a more realistic arrival fuel. Typically, there isn't time to commence the checklist, but if there is – don't, let the FMC settle down.
- Tactical (or strategic) changes to the FMC result in a genuine short-term low arrival fuel calculation. This includes the time between deciding to return/divert (*often taking up a hold or vectoring*) and that point in the NM/NNM management sequence when you actually get around to sorting the FMC. In the meantime, with EICAS ❑ INSUFFICIENT FUEL showing - starting the checklist for such situations complicates what is probably already a busy time. Deferring the checklist (*leave the EICAS message displayed*) until the FMC is updated keeps things simple.
- You're genuinely running low on fuel (*high consumption enroute, diversion to Alternate, etc*). In this case – one possibility to consider is a revision of the RESERVES figure in the FMC. If you're diverting to the Alternate after an unsuccessful approach into Destination, the RESERVES figure often needs to be revised downwards to reflect a more realistic arrival minimum at the Alternate (*usually either 30 minutes fuel or perhaps 4.2 tons to highlight the potential occurrence of* ❑ FUEL QTY LOW).

The point is that while typically it's almost an autonomic reaction to see an EICAS alert with a Checklist to run that checklist – sometimes pausing to consider the circumstances keeps things simple.

7.54. Reading Into/Beyond the Checklist

Firstly, it has to be said that most of the time, this is not a good idea. Broadly speaking Aircraft Manufacturer checklists are designed to be followed and not second guessed. When you've lost all your hydraulic fluid, and therefore hydraulic pressure, and the checklist tells you to turn first one and then another hydraulic pump from AUTO to ON – you know this isn't going to work. So why do it? Let's just **ITEM OVERRIDE** this step and get on with the NNM. At this point, your instructor will (*hopefully*) lean forward and say something along the lines of "**Stop thinking so hard – you'll hurt yourself (*or something else*) … do the checklist items.**" Harsh, but sage advice.

But there are times when the PF/Captain really needs to understand what a checklist is trying to achieve. NNM checklists are broadly speaking flow charts – and the Yes/No decision points can be critical. These points in effect allow the crew to determine the flow of the checklist and what state the aircraft will end up in at (***NNM***) **CHECKLIST COMPLETE**.

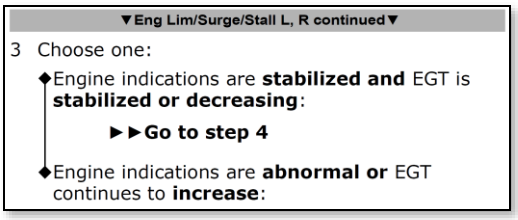


Again, most of the time these Yes/No points are based on an objective assessment and there's little subjectiveness about them. But sometimes you are being asked more than you realise – a knowledgeable 777 pilot knows the true meaning of what these questions are asking in relation to the flow of the checklist, and there are times when less objective assessment and checklist knowledge is required
… Example time.

Engine Rundown to Idle

In flight you have a failure where the engine rolls back to idle (*not failed*) even as the associated thrust lever stays at the commanded thrust level. In fact – as speed reduces, both thrust levers advance, but the affected engine remains at idle. What you do you – **Fly The Plane**, of course.

But after you run **Engine Failure Analysis**, you'll eventually end up in the ❑ **Eng Lim/Surge/Stall** Checklist, and you'll be at **this** question. At this point your engine is running at idle, powering pneumatic, hydraulic and electrical systems. There's no vibration, exceedance – or EICAS messages.


▼Eng Lim/Surge/Stall L, R continued▼

3 Choose one:

◆Engine indications are **stabilized and** EGT is **stabilized or decreasing**:

►►**Go to step 4**

◆Engine indications are **abnormal or** EGT continues to **increase**:

What's your answer going to be?

This question regarding stabilisation and EGT is a cover for what the checklist is actually asking you, which is – **Do you want to shut the engine down?** The QRH bases this decision on the Engine Indications (*Stabilized; EGT*) but sometimes this is not the entire picture. In any case …

- If you want to keep the engine running – then it's off to Step 4; we're keeping the engine running for now and may or may not configure for engine out operation.
- If you want to shut the engine down – then the checklist does that and sets you up for engine out flight. Note that this is your last opportunity to shut this engine down in this checklist – after this, if you need to do so you'll be doing it off your own recognisance.

There are a few questions like this throughout the Boeing QRH/ECL and you only really understand them if you armchair fly them and when considering the question – look at the steps that follow your selections.

By the way … when I said the engine was at Idle …

Engine at Idle Thrust Malfunction & Continued Flight

There's a failure in our simulator where the Auto Throttle system loses the ability to know where the thrust lever is at. Since the EEC doesn't know what thrust is being commanded – it sets Idle thrust, and this happens as soon as the failure occurs – on Takeoff, in Cruise, during a Go-Around; but this discussion is relevant for any engine running at "Idle" with a malfunction.

When considering continued flight with an engine at idle thrust – one of the considerations must be … **How do you know it's at idle?** It's not like there's an idle thrust detent on the N1 gauge. If you think about it, the only way you can really know an engine is at Idle is to bring the other one back to idle and compare. Having achieved that – now all you need to do is assume that it will stay at idle, particularly into the flare where idle thrust is something of a priority … **Fundamentally - you have lost control of this engine. Even it it is actually giving you Idle thrust at the moment - do you want to trust it to stay there into the flare?**

7.55. Smoke, Fire, Fumes – and then Removal

The Smoke, Fumes or Fire in the Cabin/Flight Deck event is one of the few times where you end up running multiple checklists at once – all while you have something far more important to do. At all times during this kind of NNM the primary focus of the crew must be around protecting the safe outcome of the flight – which can very quickly lead to requiring an immediate diversion and landing should the ignition source grow out of the control of the crew to contain it. So, from the get-go, you should be thinking where you'll be going and how long it will take to get there. In the worst of scenario's, with an out of control fire you're likely 20 minutes away from a very rushed away from airport forced landing/ditching. Not pretty.

While logically the flight deck should be informed as soon as the problem is discovered; sometimes the first thing the flight deck hears is both the existence of the event – and the need for Smoke Removal. Thus, the temptation can be to get straight into the **Smoke or Fumes Removal** checklist. The Boeing implementation must commence with the **Smoke, Fumes Fire or Fumes** checklist before continuing to the removal procedure. Note that both these checklists are Unannunciated.

Smoke, Fire or Fumes

Condition: Smoke, fire or fumes occurs.

Objective: To remove power from the ignition source. To land the airplane as soon as possible, if needed.

1 Diversion may be needed.

2 Don oxygen masks and smoke goggles, if needed.

3 Establish crew and cabin communications.

4 IFE/PASS SEATS switch . . . . OFF

5 RECIRC FANS switches (both) . . . . Off

6 APU BLEED AIR switch . . . . Off

7 **Any time** the smoke or fumes becomes the greatest threat:

►►**Go to the Smoke or Fumes Removal checklist on page 8.22**

Smoke, Fire or Fumes Checklist

This checklist establishes some pre-cursors (*Diversion, Oxygen, IFE, Recirculation Fans, APU Bleed Air, etc*) before directing crew as needed to the **Smoke or Fumes Removal** checklist.

The **Smoke, Fumes Fire or Fumes** checklist then ascertains if the source can be determined and "quickly" extinguished. If not, the checklist configures the aircraft for a diversion to the nearest suitable, before engaging the crew in a source hunt for the Smoke/Fumes/Fire.

It may not be immediately obvious (*especially when there's smoke all round you and you're headed high speed to land somewhere in the midst of all that's going on*) – but at this point you have been unable to quickly find the source, the checklist assumes that either the source of the Smoke/Fire/Fumes is the air-conditioning system – or it's being exacerbated by the AC. Therefore, it isolates the two systems (Pack L vs Pack R) in an attempt to ameliorate the situation.

Smoke, or Fumes Removal Checklist

Having kicked off the process properly with the **Smoke, Fumes Fire or Fumes** checklist, the Removal procedure is a little simpler. With the injunction not to delay any landing, this checklist further eliminates a few possible sources of smoke, then asks you whether the smoke is forward or aft. Based on that assessment, Outflow Valves are actioned to ~~focus the smoke in that area~~ … expedite the removal of the smoke from that area out the associated Outflow Valve. After that, you're directed back to the **Smoke, Fumes Fire or Fumes** checklist – which must still be running in the ECL of you wouldn't be here, would you?

Smoke or Fumes Removal

Condition: Smoke or fumes removal is needed.

1 Do this checklist **only** when directed by the Smoke, Fire or Fumes checklist.

2 Do not delay landing in an attempt to complete the following steps.

3 Close the flight deck door.

4 EQUIP COOLING switch . . . . Off

Note: After 30 minutes of operation at low altitude and low cabin differential pressure, electronic equipment and displays may fail.

5 Do **not** accomplish the following checklist:

EQUIP COOLING OVRD

6 Choose one:

◆Most smoke or fumes are in the cabin **forward** of mid-wing:

►►**Go to step 7**

◆Most smoke or fumes are in the cabin **aft** of mid-wing:

►►**Go to step 10**

7.56. Engine Failure at Altitude Climbing/Descending

Engine failure at altitude is traditionally conducted in straight and level flight. Thus the mode changes are from SPD LNAV VNAV PTH into L/R THR LNAV VNAV SPD (see **Engine Out Drift Down – FMA**!).

Initiating a Drift Down during a Step Climb

With the aircraft in VNAV SPD, one might reasonably assume that VNAV will continue to guard speed in the event of an engine failure during the climb, continue to maintain CLB thrust, and the aircraft would basically commence a drift down descent, albeit at cruise speed. In fact, while in VNAV SPD but with a higher altitude set in the MCP altitude selector, VNAV levels the aircraft out (*owing to the lack of thrust*), but then allows the speed to decay while maintaining level flight. VNAV will not commence a descent in order to protect selected/programmed speed because the MCP Altitude selector is set higher than current altitude. However, once the MCP altitude is reset and the VNAV … ENG OUT> modification executed, a correct engine out drift down is established.

Initiating a Drift Down during a Step Descent

With the aircraft in VNAV SPD, the aircraft is likely to be established in an idle (or above idle) thrust descent. A non-idle thrust descent is also a possibility when the step-down altitude is relatively small. With the loss of thrust of an engine failure, the descent rate will increase. Further, with the change in altitude selector to the engine out maximum altitude *(but prior to the modification execution)*, thrust on the operative engine could reduce to increase the descent rate to the new target altitude. However, with the execution of the VNAV ENG OUT modification, a drift down descent is established. Speed protection is provided throughout. Yay.

Use of ALT Hold (*this is Richard's Fault*)

One thing to watch for – particularly during an engine failure in a step climb (*where the technique tends to be used*) – is the PF selecting ALT hold to level off from the climb. In and of itself, this is not a bad reaction and is an oft taught technique, but it establishes the aircraft in an FMA mode from which it will not automatically commence a drift down descent as expected (*and usually trained*). As long as the PF is aware of this, VNAV can be engaged once the MCP altitude selector is set and the ENG OUT drift down mode executed.

In Summary – try and have your engine failure at altitude while on descent.

7.58. Tail Strike Checklist(s)

There have been almost (**but not quite**) no tail strike events in the B777-300ER. During initial flight testing, Boeing Test Pilots were unable to generate a tail strike through miss-handling because of the Tail Strike Protection System (TPS) in the PFC. There have been a few in the 777-200 aircraft, and quite a few in the more critical 777-300. With a clearance of less than a meter during a normal rotation, the risk of abnormal technique, configuration and environmental impacts is clear.

While there has been variation in the past (*see side-bar*) – current Boeing philosophy on Tail Strike events is clear. If a Tail Strike is suspected or confirmed, continued pressurised flight can cause further structural damage to the aircraft, and (*amongst other things*) the aircraft is to "**Plan to land at the nearest suitable airport**".

To this end, there are now two Tail Strike Checklists:

- The ❑ **TAIL STRIKE** checklist (annunciated); and
- The ❑ **Tail Strike** checklist (Unannunciated).

Both are essentially identical.

Tail Strike Bulletin (*ancient*) History

There's a little history here that's worth noting, if just to clarify where some of the **past confusion** has come from.

A number of years ago, Boeing published a Service Bulletin regarding tail strike across all types of 777's. The basic gist of that bulletin was:

- If you got an EICAS ❑ **TAIL STRIKE** – follow the checklist (*Depressurise, Land*).
- If a tail strike was reported (no EICAS) and you are in an aircraft without a tailskid – you were to run the checklist (*Depressurise, Land*).
- If a tail strike was reported (no EICAS) and you were in the aircraft with a tailskid – the flight could continue at Captain's discretion. The airframe would (should) have been protected.

The basis of this advice concerns the protection afforded by the crushable cartridge tailskid, and the location of the sensor that produces the EICSAS ❑ **TAIL STRIKE** message.

If you had a tail skid but didn't get the Caution – the theory was that the tailskid would have (*should have*) hit the ground and protected the aircraft – but since the sensor is still intact (no message), the rest of the aircraft would (should) have remained clear of ground contact.

This assumes that the Tailskid is in the right place to protect the entire tail airframe; and that the sensor is in the most likely / exposed / vulnerable place to detect a tail strike.

Subsequently the 777-300ER TPS has proven so effective that current model 777-300ERs are being built without Tailskid Protection. Hence, we now have a **common implementation of the handling of all Tail Strikes (detected or reported) – Depressurise, Land**.

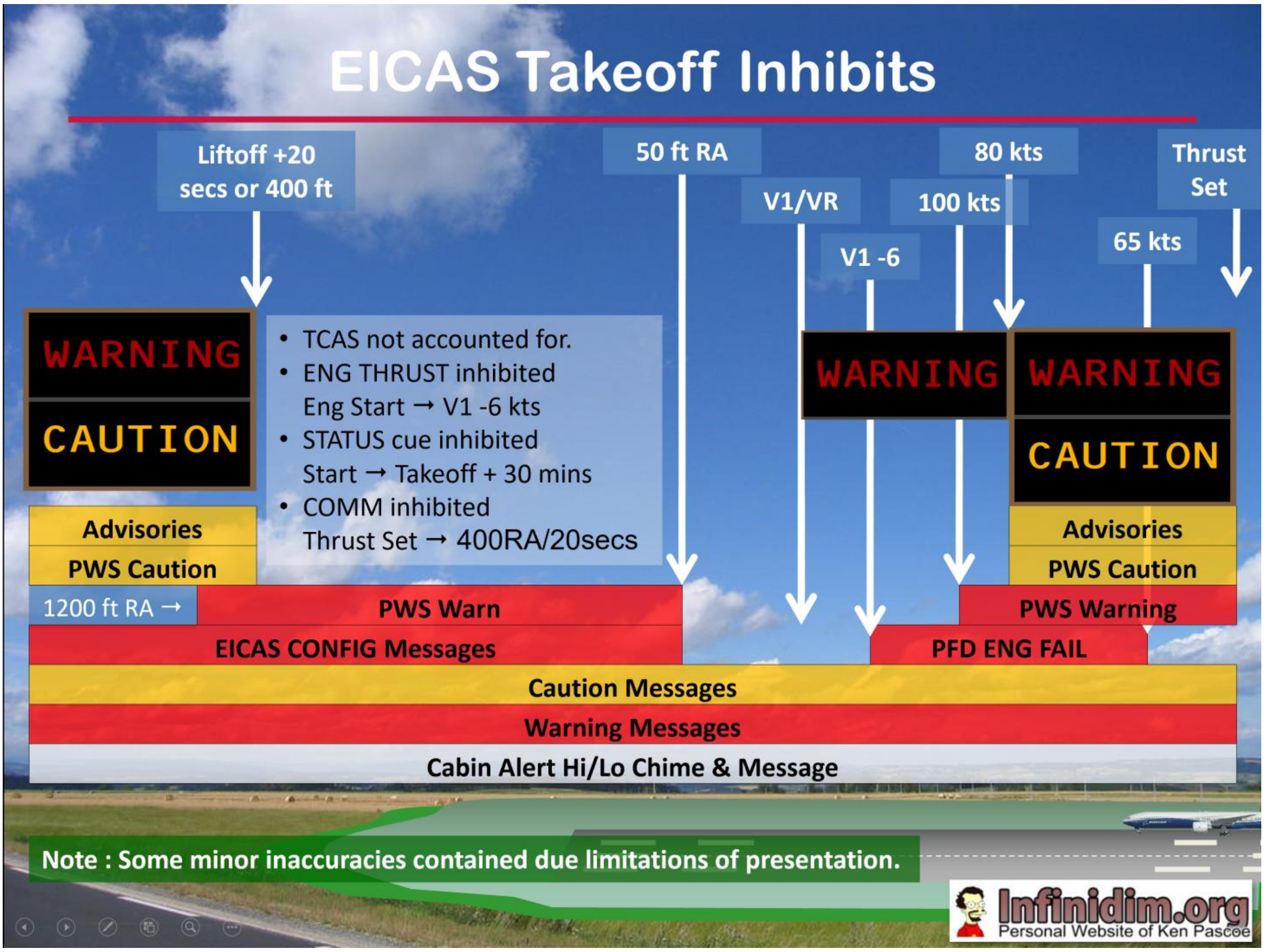
7.59. Takeoff Inhibits

The EICAS incorporates a sophisticated inhibit system that conceals from a pilot's direct attention alerts (*Memo, Advisories, Caution/Warning Lights/Aurals*) that aren't crucial to the safety of the aircraft through the various stages of takeoff. The inhibit system is used practically to determine:

- What to reject for at low speed (nominally <80 knots);
- What to reject for at high speed.

In spite of the focus given to this system by some Examiners, this system is not a memorisation item. However, the following points are worth noting:

- For the most part, EICAS Warning/Caution messages are not inhibited and will display throughout the takeoff.
- Master Warning/Caution Aurals and Lights are inhibited from before V1 until 400 ft / 20 seconds after lift-off.
- The Caution inhibit begins at 80 knots; the Warning inhibit commences at V1.
- Generally speaking, alerts that commence before an inhibit will continue on into the inhibit.
- Pilots (Captains!) should be aware that the ● CABIN ALERT Comm message and Hi/Lo chime is not inhibited at all during takeoff.



7.60. Volcanic Ash Encounters

NNM - Non Normal Maneuver

Hang onto your hats folks, here we go … **The Volcanic Ash Encounter** is the last remaining bastion of the major NNM exercise in the 777. Enjoy while you can folks – in the 787 the AP remains engaged for Dual Engine Fail/Stall and in the event of Unreliable Airspeed, a flick of a switch restores the Airspeed based on angle of attack to an accuracy of something like 5 knots.

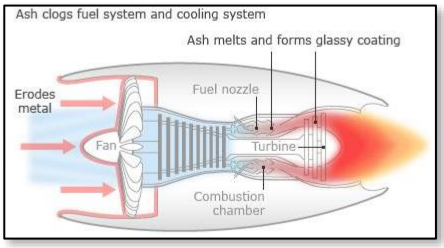
In the B777 - you're going to see some or all of the following:

- Loss of thrust from one or both engines;
- Failure of one or both engines (*be wary of the difference between engine loss and thrust loss …*);
- Loss/Corruption of Indicated Airspeed (*single or up to all three sources*) along with associated downstream system failures.
- Loss of the PFCs leading to Secondary/Direct control, no AP, FD, probably no A/Thr (*good thing all you want is Idle Descent for a while*);
- Reversion to Left PFD/ND/Upper EICAS with all other screens failed, if both engines fail. The RAT returns the right PFD/ND; the APU brings with it the lower MFD. Nothing returns where you were up to in the ECL, you're starting both NM and NNM checklists from scratch.

Anyway – this single event incorporates a host of NNM Management Procedures, Techniques and Axioms, often in conflict with each other. Each time you run this in the simulator, the basic scenario manifests differently, and even to an identical scenario – crew respond differently much of the time, more often than not correctly in their own respect. But after a while you realise the same questions come out time and time again, and some crew have better management techniques that we can all learn from.

As always – this is a techniques discussion firmly rooted in (*hopefully*) common sense and airmanship, but also a lot of experience watching and doing this in the simulator – and absolutely no actual experience in real life. While I've spoken at length to **Alastair Moody**, I'm still waiting for my first real Volcanic Ash encounter – and I spend a fair amount of effort in pre-flight and in flight doing my best to avoid it.

Volcanic Ash



Without spending time talking about what you already know – suffice to say flying in Ash is bad, and your first voluntary action should be to get out of it and protect your engines. This requires (a) a Descent; and usually (b) a Turn.

So now you're turning in **HDG / TRK SEL** - AP engaged ideally - and Descending with Idle Thrust in **FLCH SPD**. With any luck you get away without losing both your engines, retain your airspeed indications, and you're left with (*probably*) at least one malfunctioning engine, and an Unannunciated **Volcanic Ash Checklist** to do. I personally have a terrible habit of reaching up and starting the APU in the midst of all of this – a bad technique that so far no-one has managed to train me out of – but as always, I'm hopeful for self-improvement.

Then … Dual Eng Fail Stall – or is it?

1. Fuel Control Switches (BOTH) - Cutoff, then Run
2. Ram Air Turbine Swtch - Push & Hold for 1 Second

At least, that was your plan. In the sim things happen a little quicker than you'd like – or recognition takes longer than you'd planned from your armchair simulator at home – and if you haven't commenced a descent, you've got one or both engines rolling back. That leads you into **Dual Eng Fail/Stall** Memory Items. I personally consider the Airspeed and APU as memory items, but that's technique and one of the luxuries of being a Captain.

If you have commenced a descent – congratulations, while you were hoping to protect your engines, you've probably also disguised the **Dual Eng Fail?/Stall?** indications. They may not be both failed as you descend in Idle – but they could well be both Stalled near Idle. If you want to test this, you can (in **HOLD**) push each thrust lever up one at a time to see if you're getting a response. If you have one engine, then you can continue down secure in the knowledge that you'll be able to level off when you want to (maybe). If not – you need to get onto the **Dual Eng Fail/Stall** Memory Items.

If the APU is running at this point, it's all sweet – if not, you're about to lose all the screens except Yours (*I say "Yours" because if as the Captain you're not already flying, you soon will be when the right PFD/ND disappear*), including the ECL and whatever progress you've made through the outstanding NNM checklists when you cycle the Fuel Control Switches. Note – I'm NOT saying to delay the Memory Items while you wait for the APU.

Management

A quick word on Management. With my Captain hat on – I'm confident in my ability to "Manage" most NNMs, as well as my ability to do things like selecting and implementing a preferred flightpath, choosing between different memory Items, telling ATC what I want (*no requesting at this point*), considering conflicting checklists, including the Cabin into the equation as soon as I'm able, and generally **FORDEC**ing the stuffing out of this day. Or at least from where I sit in the 3rd seat in the sim – pretty sure.

Volcanic Ash Encounter Technique

- Descend (Idle) & Turn Away
- Start the APU
- Dual Engine Fail/Stall?
- Time to Manage – Hand Over

Right up until the point where I'm trying to do any of this while hand flying a 777 glider on raw data, no engines and bad airspeed. Therefore – in this scenario, my standard response is to get the aircraft into the safest immediate state that I can – Fly The Plane, Descent (Idle), Turned (Away), Memory Items (if necessary, done) – and then hand it over to the First Officer and get on with my real job. If both engines have failed, a handover back to the First Officer should not occur until RAT/APU deployment as the First Officer loses flying instruments in the initial encounter (*with loss of both engines*).

All of a sudden, the workload of flying is gone, I have 90% of my brain released from the task of flying (*some would say more*) and my capacity to deal is increased significantly. At this point as the PM/Captain, the most common mistake is to sacrifice Monitoring against Management and leave your other Pilot to deal with it all. Don't forget to Monitor – especially if the scenario does transfer to Manual Flight and Unreliable Airspeed (*and the requirement to recognise it*) is a likely consequence.

The Cabin

Logically, one or both of your engines will return, and you're headed off to whichever airport is nearest/suitable. How do I know this – 20 years of simulator exercises, that's how I know. But if you want to allow for the possibility of NOT getting your engines back – then I suggest getting your Cabin Leader into the scenario slightly before the "**Brace Brace**" call at 500 feet. Know how you're going to get her/him into the flight deck asap; exactly what you're going to say – while managing/flying/breathing.

The Question Is - Which Checklist?

So, when you're just into the Volcanic Ash checklist and you lose both engines – what do you do? **Dual Eng Fail/Stall** Memory Items of course.

With those out the way (*how easy was that*) – now you need to decide what checklist to do now. The likely choices are to continue the **Volcanic Ash** checklist, or run the **Dual Eng Fail/Stall** checklist. Which one are you going to run – considering that they are both Unannunciated and so EICAS does not offer any direction here.

First principles suggest that the checklist with the Memory Items could be considered a higher priority than a checklist that does not have them, and that's an entirely defensible position. That leads to **Dual Eng Fail/Stall**.

If you know your checklists, you also know that all the elements of the **Dual Eng Fail/Stall** checklist are (*currently*) contained within the **Volcanic Ash** Checklist (*and a few more, since the Volcanic Ash deals with not just the engine problem(s) but also … you know, the Volcanic Ash*). So, while procedurally the correct response is probably to run **Dual Eng Fail/Stall** checklist, I'd like to believe that continuing the **Volcanic Ash** checklist instead is a forgivable sin.

Either way – you're going to end up running the actual **Volcanic Ash** checklist at one point or another anyway, even if it's after you've completed the **Dual Eng Fail/Stall** checklist. Sorry – did you want an actual answer to this question?

Dual Eng Fail/Stall

Condition: Engine speed for both engines is below idle.

1 FUEL CONTROL switches (both) . . . . .CUTOFF, then RUN

2 RAM AIR TURBINE switch . . . . Push and hold for 1 second

3 Do not manually abort the start if EGT turns red. EGT turns red when EGT exceeds the start limit line (lower red line). Autostart discontinues the current start attempt before EGT becomes too high for continued engine operation.

4 Set airspeed above 270 knots.

5 APU selector (if APU available) . . . . START, then ON

Volcanic Ash

Condition: Volcanic ash is suspected when one or more of these occur:
- A static discharge around the windshield
- A bright glow in the engine inlets
- Smoke or dust on the flight deck
- An acrid odor

Objective: To exit the ash cloud and restart engines if needed.

1 Exit the volcanic ash as quickly as possible. Consider a 180 degree turn. Consider a descending turn.

2 Don the oxygen masks and smoke goggles, if needed.

3 Establish crew communications, if needed.

Tidying Up – One Engine To Go

One final odd element after the two checklists are complete is that it's quite likely that you can be left with a stalled or failed engine and no checklist on EICAS. Until you've got one engine back and levelled off – or never lost both and levelled off clear of the ash on (*at least*) one engine – this is a minor inconvenience only. But at some point you need to deal with the second engine.

How you do that depends on your Engine Failure Analysis (see **Engine Failure Analysis**). This should lead you to the ❑ **ENG FAIL** checklist (*and the option of a re-start*); the **Eng Limit/Surge/Stall** checklist (*via the Memory Items*) and the option of continuing to run the engine at reduced thrust; or the **Eng Svr Damage/Sep** checklist (via the Memory Items) and a secured engine. It will also sort out TCAS TA; Flap 20/30 other Engine NNM considerations.

7.61. Terrain Escape-ing from APProach Mode

When you combine the following points together into a scenario, you get an interesting conundrum (*ask me how I know this*).

> **31.5 TERRAIN CLOSURE RA FAILURE (GPWS FALSE WARNING)**
> *All radio altitude indications decrease indicating to the pilots that the terrain elevation begins to rise at 7000 ft/min until it reaches 200 ft below aircraft altitude. The radio altitude failure (glitch) corrects itself when the aircraft has climbed 2000 ft over the initial altitude.* ***NOTE:*** *The malfunction should be set under 4000ft AGL.* (From the Sim Manual)

- Below 1500 ft RA on an ILS Approach, the AFDS APP mode (LOC GS) cannot be disconnected using conventional mode-selection means. If you really want to get out of **APP**roach Mode – you have to both disconnect the autopilot and simultaneously turn both Flight Directors off. Then F/Ds back on and arm/engaged the modes you desire.
- A Terrain Escape encounter commences with disconnecting the AP and A/Thr, pitching up and manually applying maximum thrust. The TO/GA switch is not featured, and the AFDS typically remains engaged in whatever modes it was in when the Escape Manoeuvre was commenced.
- The most common means in the Simulator of simulating an unexpected terrain encounter (*particularly on approach, where there seems to be a singular lack of hills and mountains to be vectored towards*) is a simple IOS push button which forces the Radio Altimeter to begin to rapidly (*falsely*) reduce down to a value that tricks the GPWS into thinking the aircraft is about to hit something – 200 ft or less seems to be the number the RA settles on after the Terrain Warning has been triggered. Sometimes along the way you get various terrain cautions depending on altitude, aircraft configuration, etc – but this failure is basically a one-way freight train headed for a Terrain Escape Manoeuvre.

And then, finally …

- Some guy said once that when recovering from TCAS RA's (*and a few other Manoeuvre based NNMs*) – FLCH is a great mode that pretty much sorts out your vertical flight directors, give you back your Auto Throttle and (*as long as you have the MCP Altitude Selector set right*) pretty much sorts most of your problems out – see **Recovering from TCAS RA (or most Manual Flight NNMs)**.

All this Leads to …

On approach (in APP mode) if you commence a Terrain Escape, the AFDS remains in APP mode because the TO/GA switch is not part of the procedure. Fast forward to recovering from the manoeuvre once terrain clearance is assured – if the AFDS is in APP mode (LOC GS) and you choose to use FLCH to recover – it will only engage if the RA fault has cleared and your Radio Altitude is back in excess of 1500 ft, no matter how quickly or how many times you press it. If you really want to use FLCH – you'll need to cycle the Flight Directors to get out of APP mode. Or …

Previous advice aside … a better recovery technique tends to be to accomplish what you probably would have done earlier if you'd had more time and the GPWS warning hadn't got in the way – commence a go-around. A brief comment to your flight deck friend helps "**Ok, we're clear of terrain let's turn this into a Missed Approach – set Altitude 7000**" and once you have decent altitude to aim for – "**Go-Around, Flap 20**" – trigger the TO/GA switch(es). This leads to "**Positive Rate**" followed by "**Gear Up**" and we're off into a normal go-around manoeuvre.

Note : It's not unusual to end up below VREF during an Approach-to-Terrain Escape Manoeuvre. The QRH tells us to "***When clear of the terrain, slowly decrease pitch attitude and accelerate***" – and this is pretty good advice. A suggested technique is once clear of terrain leave the thrust where it is and lower the pitch attitude towards 10°. Once the Airspeed is above VREF, commence your Go-Around (don't forget the TO/GA switches to get out of LOC GS.

8. Non Normals on the Ground

8.1. Keep the Big Picture

A common error during NNMs on the ground is for the flight crew to forget the outside world. Whether this is an engine start abnormal, a pack failure after pushback, or something more serious, there is a tendency to forget the ground engineer connected below, ATC and the fact that the aircraft is probably blocking a taxi way while the NNM is being actioned. Keep the ground engineer and ATC in the loop, maintain the big picture during ground NNMs.

8.2. Confirmation is not required

When running Memory Items or Checklists that use the word "Confirm" during NNM's on the ground – confirmation of the intended action is NOT required. The lack of confirmation on the ground is especially useful during time critical memory items such as Engine or Cargo Fires, or other failures which are leading towards a Passenger Evacuation requirement. PM gets on with the Checklist/Memory Items in an expeditious, but careful manner.

> The word "Confirm" is added to checklist items when both crewmembers must verbally agree before action is taken. During an inflight non-normal situation, verbal confirmation is required for:
> - an autothrottle arm switch
> - an engine thrust lever
> - a fuel control switch
> - an engine or APU fire switch, or a cargo fire arm switch
> - a generator drive disconnect switch.
>
> This does not apply to the Dual Eng Fail/Stall checklist. QRH CI 2.5

Note however that this does not necessarily preclude the PM from choosing to confirm with the PF (*or the First Officer confirming with Captain*) irreversible actions during NNM events on the ground **that are not time critical**. Such a confirmation could be considered good airmanship when time is not of the essence and achieving the aim of a NNM Checklist/Memory Item accurately **as a crew** is a higher priority.

8.3. To Stop or Not to Stop …

When a NNM event occurs on the ground, one of the first considerations should be whether or not to stop the aircraft. Irrespective of which pilot is PF, this is usually the call of the Captain. The Captain should seriously consider stopping the aircraft if the NNM event is likely to lead to:

- Calling for Checklist Memory Items.
- NNM Checklists that will require the attention of both pilots (Cautions/Warnings?)
- Any potential for a Passenger Evacuation.

In particular – if there is any potential for a Passenger Evacuation – the Captain should take control, bring the aircraft to a halt, set the Parking Brake, (*decide whether to*) stand the Cabin Crew to Attention – and call for the appropriate Checklist/Memory Items.

This control handover stems from the requirement for **the Captain to be the PF during the Evacuation Checklist**, and a recommendation to avoid changing PF/PM during Checklist/Memory Items.

8.4. Who has the Radio?

When calling for Checklist/Memory Items on the ground, while the First Officer has the radio by default (*aircraft stationary on the ground*) the Captain has a brief opportunity to take the radio for the duration of the NNM. During events such as Fires, Rejected Takeoff and Passenger Evacuation the radio as a potential source of information can be determinative on the outcome of the NNM. Direct access to that information can expedite the Captain's decision process and ensure the accurate flow of information. The Captain taking the radio also leaves First Officer to run the NNM checklist/memory items without distraction.

8.5. Passenger Evacuation & Paper QRH Usage

During the ❑ **Evacuation** checklist, the removal of AC power sources requires the use of the Paper QRH (no ECL), which is made more difficult (*at night, or anytime in the sim*) by the removal of AC power and therefore the majority of flight deck light sources.

Additionally, the ❑ **Evacuation** checklist requires action items of the Captain, both at the beginning and in the middle of the checklist. CRM is best served when both crew have access to the checklist during the procedure.

Because the Dome Light remains functional through to the end of the checklist, the best solution tends to be for the First Officer to place the QRH on top of the lower MFD, turn on the STORM Light switch and run the checklist from there. In this position the checklist remains illuminated by the Dome light and both crew can review the QRH checklist as it is actioned.

Evacuation

Condition: An evacuation is needed.

1	Parking brake . . . . Set	C
2	OUTFLOW VALVE switches (both) . . . . MAN	F/O
3	OUTFLOW VALVE MANUAL switches (both) . . . . Push to OPEN and hold until the outflow valve displays show fully open to depressurize the airplane	F/O
4	FUEL CONTROL switches (both) . . . . CUTOFF	C
5	Advise the cabin to evacuate.	C
6	Advise the tower.	F/O
7	Engine fire switches (both) . . . . Pull	F/O
8	APU fire switch . . . . . . Override and pull	F/O
9	**If** an engine or APU fire warning light is illuminated:	
	Illuminated fire switch . . . . Rotate to the stop and hold for 1 second	F/O

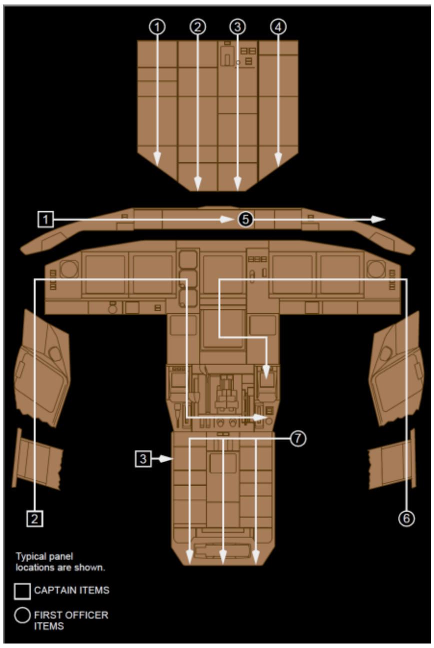
8.6. Landing NNMs & Passenger Evacuation

When landing with an abnormal that might lead to a passenger evacuation, whether forewarned and pre-briefed such as a previously existing un-extinguishable engine fire, or late notice such as an APU fire on short final, it is generally recommended that the Captain take control at some point, bring the aircraft to a stop, set the parking brake and stand the crew to stations "**This is the Captain … Cabin Crew to Your Stations.**" From this point on First Officer is the PM and will run the appropriate Recalls/Checklists and Captain retains oversight of the NNM and may also choose to take communications as well (**Who has the Radio?**).

If this doesn't occur – then the correct procedure is for the First Officer to bring the aircraft to a halt, set the Parking Brake and hand over control. The Captain will make the PA and commence the NNM - as 'PF' (*or more correctly, Captain with the aircraft stationary on ground*).

8.7. If you're going to Stop …

Anytime the aircraft is stopped on the ground with NNM's in progress, actions are taken based on **Pre-Flight Areas of Responsibility (AOR)** – See QRH CI – NNM.



This does not mean the FCOM Captain-PF/First Officer-PM AOR – the QRH CI is referring to the FCOM Pre-Flight Scan Flows actioned by Captain/First Officer during flight deck setup.

Basically – when actioning switches during a NNM on the ground with the aircraft stopped – switches and knobs are activated during the Checklist/Memory Items by the pilot that pre-flighted them before engine start. So:

- Auto Throttle Arm Switches – Captain
- Thrust Levers – Captain
- **Fuel Control Switches – <u>Captain</u>**
- Engine Fire Switches – First Officer

The QRH identifies C or F/O on the QRH Passenger Evacuation checklist, confirming the pre-flight areas of responsibilities for the relevant checklist actions.

8.8. Rejected Take Off – Give the Captain a Chance

One common error observed during a rejected takeoff (*or a landing NNM that potentially requires a passenger evacuation*) is the First Officer's need to push into the NNM cycle prior to the Captain completing the current task of executing the RTO.

Typically, the Captain will rejected the takeoff, perform the required actions, along with the First Officer calls, verifications and ATC call. As the aircraft comes to a halt, the Captain stows the reversers and sets the parking brake, the First Officer will launch into the assessment phase – calling the EICAS or analysing the engine failure.

At this point the Captain's focus needs to be task protection. The Captain's task is to bring the aircraft safely to a halt, set the Parking Brake and decide whether to stand the crew attention to the doors, and execute that decision. Only then should the Captain allow the NNM to move forwards and ask the First Officer for an assessment. Captains need to focus on task to completion, so First Officers need to be careful distracting Captains during this critical phase.

8.9. Standing the Crew Up

In the event of a NNM on the ground (*takeoff, landing, taxi, etc*) that includes any potential for an Evacuation, the Captain needs to decide whether or not to stand the crew up with the Alert PA. This question applies whether rejecting a takeoff at high speed or a serious malfunction during taxi – or parked on stand.

Some Captains believe that unless there is a clear indication that an Evacuation is likely, it's not prudent to raise the crew to high alert, because it increases the risk of the Cabin Crew peremptorily commencing an evacuation by themselves. The risk associated with not standing the crew up is reducing the time crew could have to mentally rehearse their actions in the event of an evacuation, to assess the cabin and outside area and carry out other actions associated with this phase, in accordance with their training.

The circumstances under which the Cabin Crew are likely to commence an evacuation are clearly trained and documented in the Cabin Crew Emergency Procedures Manual (B9).

- Command required and forthcoming from the Flight Crew
- Command required from the Flight Crew and not forthcoming;
- Command not required from the flight crew

The last category includes Ditching (*prepared or otherwise*); if the aircraft has broken up; or other life-threatening circumstances.

The "***Command required … not forthcoming***" category includes allowing 30-60 seconds for Flight Crew to assess and action the appropriate drills, and crew subsequently contacting the flight deck in the event of no initial contact. No contact is interpreted as a possible incapacitation and contact will be initiated through a Cabin (Pilot) Alert Call, and/or by the flight deck door Emergency Access Code. Hence the initial contact from the Flight Deck Crew – either the Alert PA ("**This is the Captain, Cabin Crew to your Stations.**") or the Evacuation Unlikely PA ("**Cabin Crew and Passengers, Remain Seated.**") is crucial to let the crew know that you are alive and (*capable of*) dealing with the NNM.

In the event that there is any reasonable likelihood of a passenger evacuation the conservative response is to prepare the crew with the Alert PA.

Brake Fires & Evacuation

In and of itself, a brake fire owing to a rejected takeoff is both a likely consequence of a high-speed RTO, and an unlikely cause for a passenger evacuation, especially if fire services attend the aircraft promptly.

Certification standards take place under maximum weight high speed rejected takeoff with the brakes worn to within 10% of their service limitations, and the brakes are untouched for 5 minutes prior to fire services attending. Despite what the Test Pilots might want to happen … see here.

8.10. TailPipe Fire

Tailpipe Fires occur on the ground, usually during engine start, and are a product of excess fuel in the combustion/turbine/exhaust that ignites. Highly visible flame/smoke can be the result from the engine (exhaust or inlet). While spectacular, Tailpipe Fires have very little impact on the engine itself with damage typically constrained to the aircraft itself (*lower wing surface, flaps, nerves of witnesses, etc*).

Fire Eng Tailpipe L, R

Condition: An engine tailpipe fire occurs on the ground with no engine fire warning.

1 FUEL CONTROL switch (affected side) . . . . CUTOFF

2 Advise the cabin.

3 Choose one:

◆Bleed air is **available**:

►►**Go to** . . .

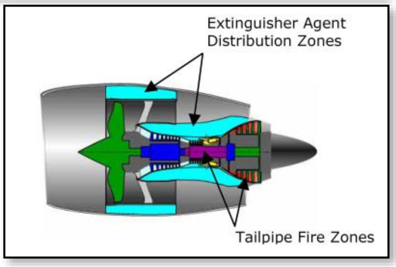
◆Bleed air is **not** available:

Advise the tower.

■ ■ ■ ■

A typically Tailpipe Fire will **not** result in an engine fire warning on the flight deck – the only indication may be rising EGT and a highly excited ground engineer. The following points are worth noting:

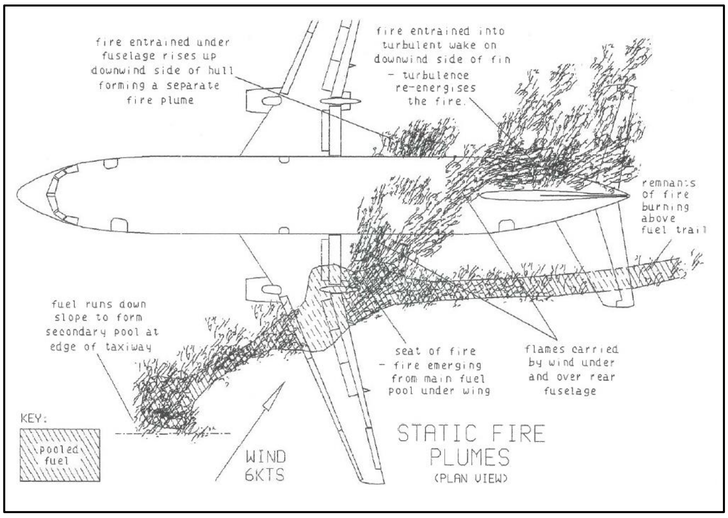
- The priority is to Shutdown the engine to halt fuel flow; then
- Motor the engine to remove any remaining fuel.
- **Do not use the Engine Fire Switch** – this will remove air supply to the engine and prevent the motoring procedure to remove any remaining excess fuel.
- **Do not use the Engine Fire Extinguishers** – these discharge outside the engine core, in parts not affected by a tailpipe fire.



Given the nature of this malfunction, there is some risk or a pre-emptive passenger evacuation by the Cabin Crew (or Passengers) – so standing the crew at alert prior to actioning the **Fire Eng Tailpipe** checklist might be appropriate.

8.11. Passenger Evacuation & Clearing the Runway

The issue of whether to clear the runway prior to a passenger evacuation (*as part of a rejected takeoff*) is hotly debated amongst trainers and crew alike. The benefits of clearing the runway usually revolve around leaving the runway open for airport operations and potentially turning the aircraft into wind in the event of engine/APU/cabin fire.



One of the dangers of leaving the runway, particularly when a fire is involved, is the potential to expose the aircraft to a crosswind that could burn across the fuselage and turn and engine fire into an airframe fire. At some airfields where taxi ways are narrow the aircraft can be left in a position where access to an engine fire by fire services can be significantly restricted. Airfields that include taxi ways with bridges across roads and waterways can cause similar issues with fires on the ground.

Generally, the conservative approach is considered to be to bring the aircraft to a halt on the centreline of the runway and commence the required NNM procedures. Any turn off the runway must be undertaken in full knowledge of the prevailing wind and ideally briefed as part of the emergency briefing, and potentially updated as the aircraft approaches the runway in reference to the prevailing conditions.

A similar issue exists after a high speed rejected takeoff where passenger evacuation is not required. Typically, there is a limited time period before the potential for a brake fire must be considered. While clearing the runway might well be considered a friendly action to airport operations – doing so onto a narrow taxi way where fire services can't access the brakes needs to be a higher consideration.

9. Engine Failure After Takeoff (EFATO)

CAUTION

This document espouses a paradigm of identifying the severity of engine malfunctions and the requirement to action memory items after an engine malfunction based on the EICAS/Engine/Airframe indications that are seen after the failure cycle is complete and more often after the EECs have shut the engine down (EICAS ❑ ENG FAIL).

This now decade old paradigm is rooted firmly in the current QRH Engine Malfunction Condition statements and has been adopted by a number of 777 airlines internationally. During implementation it was discussed and validated with Boeing and GE by the author after the QRH changed radically in the early/mid 2000's. This paradigm change by Boeing was intended to radically reduce the occurrence of un-necessarily running checklist memory items at low altitude after takeoff for engine malfunctions that were otherwise handled by the EECs/EICAS. The following sections reflect this philosophy.

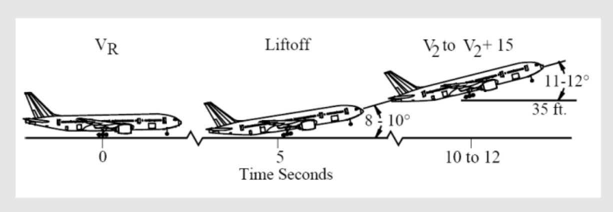
Engine Failure Analysis – a Paradigm Change   Engine Failure Analysis   AICC – Announce, Identify, Confirm, Commence

A more traditional approach is to chose whether or not to secure the engine (**Eng Svr Damage/Sep** memory items) based on what happened at the point the engine failed (*such as was there engine/airframe vibration*). Additionally, in the past we would run **Eng Svr Damage/Sep** memory items for any failure where an engine rotor had seized. At the time this approach was based on the Engine Malfunction condition statements that existed since the first 777s were delivered in the 1990's, prior to the aforementioned QRH changes. I believe the traditional approach is no longer necessary and carries risks that we are no longer required to engage with.

You will of course do what your airline Training/Standards department requires.

9.1. Engine Failure After Takeoff (EFATO) – Pitch Attitude

Students are often taught during engine out training to target a pitch attitude of anything from 8° to 12° after takeoff rotation. This is because a pitch attitude more than this usually results in a subsequent loss of airspeed to V2 (or below) and a necessarily correcting pitch change to recover. Typically, engine failures in the simulator are practiced at maximum landing weight with de-rated thrust.



It is common (*in the simulator*) to see a student pitch to about 12° (*as indicated in the FCTM*) after an EFATO which initially results in a stable speed – but then as the Landing Gear retracts the speed decays and a pitch attitude at or below 8° is usually required (*with an associated loss of climb performance*) to recover. Typically, this recovery manoeuvre is necessary just as the student has commenced trimming the aircraft – hence in some circles it has become common practice to teach pilots to aim for 10° in the event of EFATO.

However, the Boeing FCTM is quite specific in this area. It should be noted that Boeing FCTM guidance is intended to cover the full operating envelope of the aircraft – from lower weight take-offs with high thrust settings, to higher weight take-offs with de-rated thrust. Engine out takeoff rotation should have the following characteristics.

- Flight director pitch commands are not used for rotation.
- Rotation at ½° per second less than normal (*i.e. 1½° to 2° per second*)
- **Towards** a pitch attitude 2° to 3° below the normal all engine target (*i.e. 12° to 13° Nose Up*)
- Lift-off should be achieved in about 5 seconds (*1 second more than that for All Engine*) with a typical lift-off attitude of 9°
- Once Airborne adjust pitch attitude to maintain desired speed (V2 to V2+15 knots). Note that shortly after airborne this is the guidance the Flight Directors should provide.

As such, it is incorrect to teach (or target) a pitch attitude of 8° to 10° for EFATO - not the least of which because this may delay lift-off. The best advice regarding this issue is to follow the FCTM rotation guidance. Then once airborne, fly the aircraft until the gear is fully retracted and the pitch attitude and speed stable, before commencing a distraction such as trimming. Beware of the flight director indications until you have achieved this stability – continue to fly attitude and airspeed until fully airborne and stable. **At this point the Flight Directors provide guidance to achieve V2 to V2+15 and are valid for use.** Note that if the aircraft is allowed to slow to less than V2 the Flight Directors may well command a descent to recover the speed. Finally, the increase in drag associated with gear retraction can be just the factor that turns a slightly high pitch attitude with a stable airspeed into an airspeed below V2 event.

9.2. Engine Out, High Weight, High Altitude, Turning

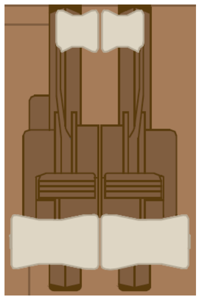
During an EFATO, the aircraft's angle of bank at low speed will be limited by the AFDS. This protection keeps the aircraft clear of the increase in stall speed during turns, as well as providing some degree of compliance with the design of EOSIDs which require an angle of bank of not more than 15° (still air)

> **Note:** The AFDS limits the bank angle to 15° until V2 + 10 knots to maintain at least adequate maneuver margin. The bank angle limit increases to 25° by V2 + 20 knots if LNAV is engaged, or when HDG SEL or TRK SEL is engaged with the bank limit in AUTO.

However, this protection is not available once the aircraft has commenced acceleration. Crew need to be aware that the combination of large angles of bank (*both Heading/Track Select and LNAV will command angles of bank well in excess of 15°*) and the usual practice of Flap retraction 20 knots below minimum flap manoeuvring speed can result in a low speed excursion, including EICAS **AIRSPEED LOW** and EICAS **AUTOPILOT**. This is exacerbated when manoeuvring engine out in marginal performance conditions (*high weight, high density altitude*).

This condition can be corrected by either delaying acceleration until the engine out manoeuvring is complete or limiting the angle of bank. Note that limiting angle could compromise the lateral splay and therefore terrain clearance – see **Engine Out Takeoff – When Do We Accelerate?**

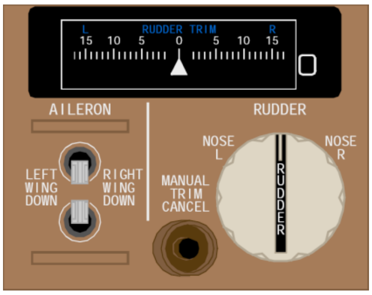
9.3. Thrust Lever Usage while Engine Out



During engine out flight, some crew prefer to keep both levers up in parallel while others keep the failed thrust lever at idle. Boeing provide no specific guidance on this, although it could be said that all the engine failure checklists dis-engaged/dis-arm the associated auto throttle and require the thrust lever of the failed engine set to Idle, then do not refer to it again.

The significant dis-advantage of not keeping the failed thrust lever in the idle position is that it can promote confusion on the flight deck between the operating vs failed engine. Workload is increased during Autothrottle operation as the failed thrust lever must be continually matched. One advantage of keeping the failed thrust lever in the idle position is that it gives you somewhere to rest your arm while following through Autothrottle operation of the operative thrust lever.

9.4. EFATO – Trimming



Boeing specifically delineate the rudder trim as in the PF's area of responsibility. As such the technique of the PF asking the PM to set a specific number or trim units is clearly against the intent of the Boeing SOP, and not encouraged by Manufacturer SOPs.

This technique comes generally from an observation during EFATO simulator training of the PF reaching for the rudder trim shortly after rotation and either (a) focussing on the trim to the detriment of aircraft flight path control; or (b) trimming in the wrong direction.

This issue is usually the result of unfamiliarity with the rudder trim control (*a training issue*); or the tendency of the PF to trim too early after an engine failure.

The solution to this is usually to delay trimming until the aircraft is stabilised, in trim (*sufficient rudder deflection to centralise the control wheel*) and climbing adequately. Trimming prior to this point (*and prior to the completion of the gear retraction cycle*) is usually premature. Waiting for 200 ft so you can get the Autopilot engaged is not a bad idea either. So …

A suggested technique is to first concentrate on flying the aircraft to 200 ft RA. This is the earliest point that the AP can be engaged – if the aircraft is under control, climbing adequately and in trim (*rudder input sufficient to result in zero control wheel input*); the AP **should** be engaged. Then make a conscious decision to review the need for trimming (*has the TAC failed?*) and deliberately establish a trim setting appropriate to the rudder demand. Typically, by 200 ft the EICAS inhibit has ended, and while it would be inappropriate to start running Checklists at this stage, a quick look can confirm the status of the TAC if there's any doubt, rather than peremptorily releasing the rudder.

There are a number of home-brew techniques for trimming such as using Fuel Flow on the operating engine as a numeric guide (14 tons/hour needs 14 units); or approximate trim settings (Climb : 12; Cruise : 6; Descent : 3 Units) which generally work well enough – but essentially sufficient trim achieves control wheel neutral with a slight angle of bank and small displacement of the slip indicator towards the live engine. That's what your Examiner is looking for.

9.5. Engine Out Takeoff – When Do We Accelerate?

Most airlines construct their engine out procedures (EOP) to be flown to completion at a maximum speed of V_2+15 and an angle of bank of 15°. Thus, irrespective of the published engine out acceleration altitude, acceleration is delayed until after engine out manoeuvring is complete, to ensure the flight path is contained within the design area.

Airline EOP's for the 777 involving turns are typically based on a maximum speed in the turn of 200 knots. This allows for a heavy weight V2 with a 15 knot additive. Thus, on the face of it, EOP's must be complete prior to accepting acceleration. However …

The angle of bank commanded on takeoff by the 777 AFDS in TOGA or HDG/TRK SEL varies with airspeed in proximity to V2. As the aircraft accelerates the angle of bank is increased (typically) towards 25°. As it turns out, the radius of turn of a heavy weight aircraft at UP speed (*Max UP is 263 kts at Max TOW*) with 25° angle of bank is less than the turn radius of the same aircraft at 200 kts and 15° angle of bank.

As such it is not required to delay acceleration because of a promulgated EOSID. Any requirement to do so will be clearly annotated on the EOSID for the associated runway.

9.6. Engine Fire on Takeoff – Early Acceleration & Climb Thrust

A commonly observed event in the simulator during a ❑ **FIRE ENG** on takeoff is the early acceleration of the aircraft - often due to an early two-engine altitude capture that is no longer justified by the remaining single engine performance. The use of FLCH SPD by the crew in a recovery attempt results in setting CLB (or CON) with the potential inability of the aircraft to accelerate for flap retraction - is also a common error associated with this scenario. Hard to believe, but there are some circumstances where **FLCH SPD** is not the mode of choice …

The solution to this is usually to revert to basics – trigger the TOGA switches to return the FMA to **THR TOGA TOGA** then review the need for another lateral mode (**LNAV**? **TRK SEL**?). If acceleration is required (*prior to ALT capture*) the PF may need to increase the speed on the MCP.

9.7. Fly The Aircraft – What does it mean?

This axiom has been over used in Aviation (*and perhaps this document*). In the training environment – and during line operations when things are getting a little tense – you'll hear these words used as an admonishment, a reminder, as encouragement, as criticism, as a standardisation. But when the student hears it – will he or she know what it means? How do you implement **Fly The Aircraft** practically? What are you looking for when assessing it?

In the context of this discussion (EFATO) – Fly The Aircraft is the physical control of the aircraft during and after the point of thrust loss associated with an engine malfunction. It refers to the control inputs (*Rudder, Aileron, Elevator **and** Thrust Lever*) actioned by the PF to achieve **Attitude** (in all three axis) and **Performance**. In actuality – it's the achievement that's all important. You set Attitude and Thrust to achieve **Performance**.

What performance? Without clear criteria in the mind of the PF, Fly The Aircraft degenerates into a high minded philosophical concept with little real application to an Engine Failure. After an engine failure, prior to engaging the AP, the PF needs to achieve the following Attitude/Performance (Power + Attitude = Performance)

Pitch : About 10-12° (+)	**Roll** : Wings Level	**Yaw** : Slip/Skid Centered	**Thrust** : TOGA/Sufficient	**Speed** : Min V_2

- It is incorrect to teach a specific pitch attitude for engine out flight (see **Engine Failure After Takeoff (EFATO) – Pitch Attitude**). The intent of pitching the aircraft is to attain and maintain speed – V2 to V2+15 by certification. That said, students need something to aim for initially and once the aircraft is airborne and climbing; 10° works well enough under most conditions. More than this is required to ensure FCTM compliance during the Takeoff Rotation (12°-13°); and about the same attitude work well a couple hundred feet later once the gear is up and flightpath is fully under control – but between 50ft and 200ft – 10° tends to be the pitch attitude that retains your V2 during the gear retraction cycle.
- Once flight control is established, the correct lateral/longitudinal attitude during trimmed engine out flight is a neutral aileron control wheel deflection with a small angle of bank towards the live engine – this is what the PF should be aiming for during flight/trimming. That said, there's nothing wrong with starting with wings level/ball centred initially, and once the aircraft has settled down, optimum performance with control wheel neutral should be attained.

Prior to AP engagement after 200 ft AGL, the PF should make a positive check that **Power + Attitude = Performance** is correct – then engage the AP at 200 ft (*with or without trimming*) and move onto the next phase of the NNM.

9.8. AICC – Announce, Identify, Confirm, Commence

During training a model is often used during engine failure sequences to lend structure to one of the few non normals that doesn't depend solely on the EICAS messages to diagnose, and is trained most often during a critical phase of flight – one such model is AICC, which can be used for engine malfunctions.

AICC is a four-phase paradigm to call, analyse, confirm and action the indications associated with an engine malfunction during takeoff (*or at any time*). **Announce** the problem; **Identify** the specific failure; **Confirm** the identification; **Commence** the appropriate procedure.

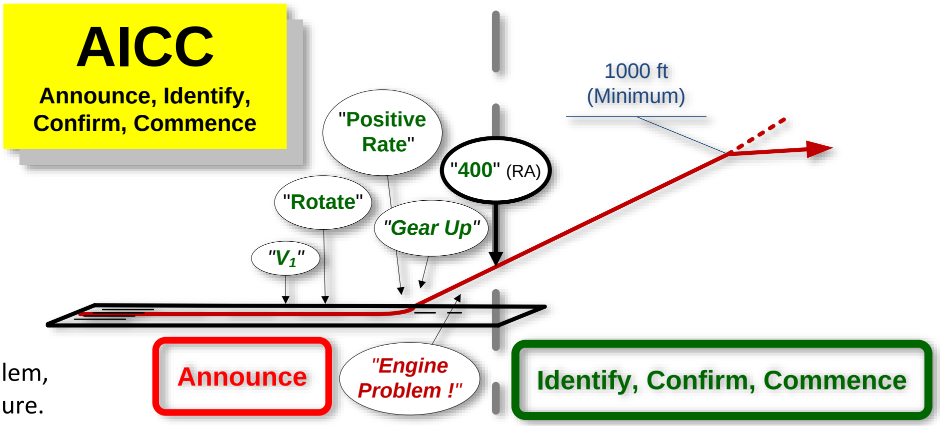
Note that while the following discussion applies AICC directly to an engine failure at a critical point during takeoff – AICC can in fact be applicable any time an engine malfunction occurs.

Nothing contained within this procedure should be seen to diminish the authority of the Captain to exercise judgement in altering the procedure as required to assure a safe outcome when dealing with the situation.

Announce

PM : "**Engine Problem.**"

PF : "**Check.**"



An engine malfunction is identified through a variety of means. At the point of detection, a clear and unambiguous statement is be made by the first pilot to observe an indication of the problem, typically the PM. The **Announce** phase is typically prior to 400 feet at which point the PM needs to communicate clearly that there is a problem, but not enter into any analysis of the failure.

- EICAS Warning/Caution/Message
- Abnormal Noise/Vibration
- Abnormal aircraft or engine handling/operating characteristics.

At this point of the failure the **Announce** step **does not** attempt to perform any analysis of the failure, nor does it necessarily identify the engine affected. The primary intent of **Announce** is to ensure situational awareness of the problem by both pilots. Note the use of the word "***Problem***" rather than "***Failure***" which could be confused with reading the EICAS.

The Announce call itself for an engine malfunction can be either the generic "**Engine Problem**" or the failure specific EICAS Message:

- "**EICAS … ENGINE FAIL** / **ENGINE THRUST** / **FIRE ENGINE** / (**LEFT**/**RIGHT**) *" – Engine Problem (*as displayed on EICAS*)
- "**Engine Problem**" – Various Engine Problems (*as identified by EICAS/Engine/Thrust/Airframe indications*)

* Note that modern SOPs should permit the crew to call the EICAS message related to an engine failure/fire (including the Left/Right identifier) at any time, even shortly after takeoff prior to being asked by the PF to identify the failure – see **Takeoff Non Normal Calls** for a discussion on this.

This is a break from the tradition of not identifying an engine failure as left/right until an analysis has been completed and is based upon the introduction of EICAS into our flight decks. **Any engine problem that does not include a specific Left/Right EICAS message should not involve initially calling which engine shows the malfunction.** It is also acceptable for a crew member (*as a matter of personal preference*) to decline early identification and opt to choose to call "**Engine Problem**" rather than "**EICAS ENG(ine) FAIL LEFT**" prior to the Identify phase of AICC.

Identify

PF : "**Identify the Failure.**"

PM : "**EICAS ENGINE FAIL LEFT and TAC. We have Airframe Vibration – Recommend Engine Severe Damage Separation Left Memory Items.**"

Once aircraft control and flight path is established the PF calls for the PM to "**Identify the Failure**". This commences a brief process to identify which of the NNM Engine Malfunction checklists is appropriate.

This process should commence after flight control is established, after AP engaged, after 400 ft, after the PF has considered any immediate engine out procedure (EOP) navigation requirement (*not necessarily in that order*). The **Identify** process consists of:

- Calling relevant displayed EICAS Messages.
- (Unusual) Airframe Vibration assessment.
- (Unusual) Engine Instrument Indications (*if required*).

Unlike the previous engine failure analysis paradigm, most failures now do not require a detailed engine instrument indication assessment. Caution should always be exercised in identifying failures that are not clearly identified by an EICAS message. Refer to **Engine Failure Analysis** and **Engine Failure Analysis – a Paradigm Change**.

The PM should verbalise the high points of the analysis and state the assessment in terms of the recommended checklist/memory items, giving the PF enough information to be able to confirm the identification.

- "**EICAS ENG FAIL LEFT, no Airframe Vibration ... Recommend ENGINE FAIL LEFT Checklist**."
- "**EICAS ENG THRUST LEFT, we have some Airframe Vibration ... Recommend Engine Limit/Surge/Stall Left Memory Items**"
- "**EICAS ENG FAIL LEFT, TAC. There's Airframe Vibration ... Recommend Engine Severe Damage/Separation Left Memory Items**"
- "**EICAS FIRE ENG LEFT**"

Confirm

PF : " **Confirmed ...** " ; or

PF : " *(Name the Identified Failure)* **Confirmed ...** "

It is now the PF's task to confirm the PM's assessed failure identification. PF's primary task is always to fly the aircraft, but the confirmation of the PM's assessment should be completed without delay. Apart from confirming the diagnosis of the failure itself – the Left/Right Engine aspect of the failure is verified by the PF as well.

There's always the possibility that the PF does not agree. In which case an appropriate response may be as follows, although the provision of additional information to guide the PM's assessment may be advisable.

PF : " **Negative, Identify the Failure.** "

The Confirm stage leads directly into the **Commence** stage, initiated by the PF.

Commence

PF : " **Confirmed ... (*Commence*) Engine Severe Damage/Separation Left Memory Items.**"

If the PF confirms the assessment of the failure, the PF can immediately initiate the recommended Checklist/Memory Items as appropriate. Memory Items are commenced in accordance with documented SOP's (see **Initiating & Actioning Checklist Memory Items**).

PF should continue provide attention to the flight path and navigation requirement of flying the aircraft. Often action needs to be taken during the NNM Commence phase relating to the 3rd segment – acceleration and configuration. Refer to **Acceleration, Configuration and Memory Items** for a discussion on acceleration during memory items.

9.9. Engine Failure Analysis

When an engine malfunction occurs during any phase of flight, the crew are required to assess the malfunction in order to identify the specific checklist required for the NNM prior to calling for the checklist/memory items.

Engine problems can be detected through EICAS messages such as ❑ ENG THRUST or ❑ ENG FAIL. Alternatively, the engine problem could well involve unusual engine indications with/without external stimuli such as noise, airframe vibration, flames in the inlet exhaust, lack of/abnormal response to thrust lever movement and various degrees of asymmetric flight.

In any case – the intended outcome of the **Analysis** is to identify which of the engine failure checklists is the most appropriate response to the malfunction.

Eng Svr Damage/Sep L, R

Condition: One or more of these occur:
- Airframe vibration with abnormal engine indications
- Engine separation

Eng Lim/Surge/Stall L, R

Condition: One or more of these occur:
- Engine indications are abnormal
- Engine indications are quickly nearing or show an exceedance
- Abnormal engine noises are heard, possibly with airframe vibration
- There is no response to thrust lever movement or the response is abnormal
- Flames in the engine inlet or exhaust are reported

[] ENG FAIL L, R

Condition: Engine speed is below idle.

Objective: To restart the engine if needed, or configure for single engine operation.

Checklist Priority

Using the EICAS checklist prioritisation philosophy (See **Prioritisation of NNM Checklists**) and common sense, crew should start at the top of the priority list, eliminating checklists until the appropriate response is selected.

- ❑ FIRE ENG (*displayed on EICAS*) Memory Items
- **Eng Svr Damage/Sep** (*Unannunciated*) Memory Items
- **Eng Lim/Surge/Stall** (*Unannunciated*) Memory Items
- ❑ ENG FAIL (*displayed on EICAS*) Checklist

An Analysis Flowchart

All failure analysis commences with the EICAS. Please note that the following technique and flowchart come from documentation review, discussion and experience – but not from Boeing.

❑ FIRE ENG is analysed using standard EICAS/ECL procedures. If it's not a FIRE ENG ...

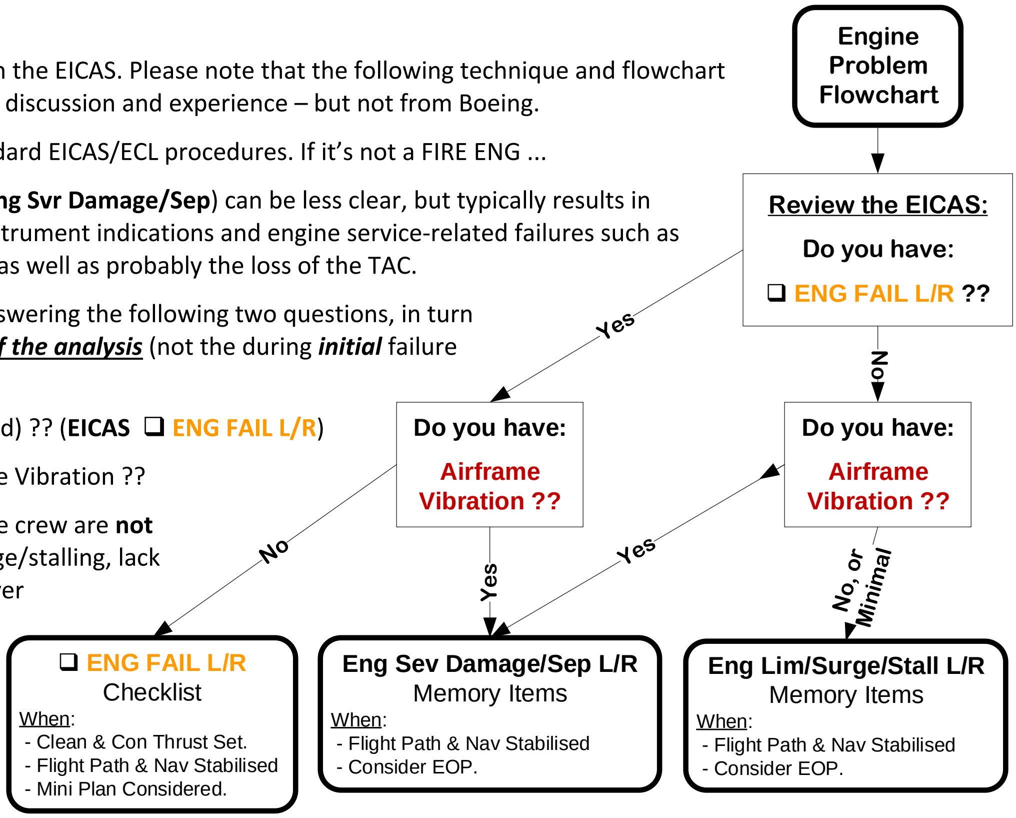
Engine Separation (*leading to* ❑ **Eng Svr Damage/Sep**) can be less clear, but typically results in total thrust loss, missing engine instrument indications and engine service-related failures such as hydraulic/electrical system events as well as probably the loss of the TAC.

Further analysis is facilitated by answering the following two questions, in turn ***based on indications at the time of the analysis*** (not the during ***initial*** failure onset):

Q1 : Is the Engine Shut Down (Failed) ?? (**EICAS** ❑ ENG FAIL L/R)

Q2 : Do we have (unusual) Airframe Vibration ??

Note that during this analysis phase crew are **not** looking for a limit exceedance, surge/stalling, lack of/abnormal response to thrust lever movement, engine flames or asymmetric flight, etc. Assessment of these conditions are not necessary at this point - these indications lead ***into*** the analysis process and are no longer required as part of it.



If the engine is still running (no ❑ ENG FAIL L/R), the Airframe Vibration assessment allows for minimal vibration leading to the ❑ **Eng Lim/Surge/Stall** checklist/memory items. At this point the crew need to ask themselves what they want to achieve – a malfunctioning engine at idle thrust, or a malfunctioning engine shut down/secured. The answer will depend on the severity of the failure. If the engine/airframe combination has significant airframe vibration – crew are likely to want to proceed straight to shutting the engine down (❑ **Eng Sev Damage/Sep**) rather than leave the engine running at idle thrust (*for the* ❑ **Eng Lim/Surge/Stall** *checklist to secure later*). Note the option of commencing the Limit/Surge/Stall checklist/memory items and upgrading to the Severe/Damage Separation remains available.

The PM should summarise the indications that lead to the specific checklist, stating the title of the recommended checklist as the result of the analysis - arming the PF with the ability to confirm the failure identification and call for the agreed checklist/memory items. See **AICC – Announce, Identify, Confirm, Commence**.

9.10. Engine Failure Analysis – a Paradigm Change

A re-design of the Boeing 777 QRH in 2007 brought a paradigm change in engine malfunction handling on the 777. One of the drivers behind these changes was to reduce the un-necessary requirement to action memory items at low altitude after an engine failure during takeoff.

This change manifests in a few key areas:

- The analysis of an engine failure for the purpose of checklist selection reflects on the failure indications ***at the time of the analysis*** – not the time of the failure. This means that if there was a loud bang, airframe vibration, and/or engine limit exceedances during the failure – only those aspects of the failure that persist through to the point of the analysis are considered.
- Engine (Severe) Damage is not indicated by engine rotor (N1/N2/N3) seizure; only by the conditions stated in the ❑ **Eng Sev Damage/Sep** checklist – which essentially comes down to (*the severity of*) ongoing Airframe Vibration.

These two factors result in sweeping changes in engine malfunction handling. In all but a few extreme engine failure scenarios, memory items (*that is the Lim/Surge/Stall or Severe Damage/Separation*) are not required.

It must be clearly stated that an engine malfunction that causes a sudden seizure of an N1/2/3 rotor is likely to result in damage to the engine such that airframe vibration is highly likely to <u>occur and continue after engine shutdown</u>. Such continued (significant) airframe vibration is a condition statement of the Engine Severe Damage/Separation Checklist and therefore requires Checklist Memory Items. But without that ongoing vibration – the Memory Items are not required.

ENG FIRE SWITCH … PULL

Another significant result of this change is that whereas previously a "damaged" engine (*N1/N2/N3 seizure, engine vibration during the failure, etc*) would result in the Engine Fire Switch pulled at low altitude, under the new paradigm the Engine Fire Switch will not be pulled at all.

Boeing and GE have been consulted extensively regarding both the changes to the 777 QRH and use of the engine fire switch. Boeing's response confirmed the desire to minimise the use of memory items at low altitude and the reduced requirement to run either the Lim/Surge/Stall or the Severe Damage/Separation checklists for failures that result in engine speed below idle.

> **1 Engine Fire Switches**
>
> In (normal position, mechanically locked) – unlocks automatically for a fire warning, or when the FUEL CONTROL switch is in CUTOFF.
>
> Out –
> - arms both engine fire extinguishers
> - closes the associated engine and spar fuel valves
> - closes the associated engine bleed air valves
> - trips the associated engine generators off
> - shuts off hydraulic fluid to the associated engine–driven hydraulic pump
> - depressurizes the associated engine–driven hydraulic pump
> - removes power to the thrust reverser isolation valve.

9.11. In Flight Engine Start

In flight engine start is usually attempted subsequent to an engine failure where the engine has been assessed damage free and the need to re-start the engine has been established. This usually takes place as part of the ❑ ENG FAIL checklist, although the ❑ **Engine In-Flight Start** checklist also exists for this purpose.

> **▼Eng In–Flight Start L, R continued▼**
>
> 5 Monitor EGT during start to prevent an EGT exceedance. Autostart allows EGT to exceed the in-flight start limit.
>
> 6 Do not interrupt autostart. Only abort the start if:
>
> There is no oil pressure indication after the EGT increases.
>
> EGT quickly nears or exceeds the start limit.
>
> No further autostart attempts are needed.

The EEC's on the GE90 will allow the inflight EGT start limit of 825°C to be exceeded during the start cycle. This is annunciated as an EGT exceedance on the EICAS engine parameter display. The EEC's will intervene at EGT 875°C, momentarily interrupting fuel flow to protect the engine. Neither the lack of protection of the inflight EGT start limit, not the limited protection offered at 875°C should be interpreted as tacit approval to allow the start to exceed the inflight start limit.

The engine in flight start procedure raises some issues, particularly for new Captains. Although Autostart will be used to start the engine, depending on engine type the inflight EGT start limit will not be applied by the Autostart system. As such the decision about whether to allow a high EGT during the start should be made prior to commencing the start, and the Fuel Control switch should be guarded until the start is complete. Therefore, Captains may want to evaluate who should fly the aircraft, and who should start the engine. In either method – a quick discussion to review the impending start is a good practice to follow.

Consideration could be given to using the lower MFD for the secondary engine instruments to assist in the start – typically the NNM checklist on the lower MFD forces a compacted engine display which may be less than ideal for an inflight start on a miss-behaving engine. The ECL could be run on the PM's ND. Another alternative would be to briefly review the compacted engine display with a view to the expected indications during the start.

9.12. TO2 … Engine Failure … TOGA … VMC A/G?

The Boeing FCTM clearly indicates that when utilising fixed thrust setting takeoff de-rates (TO1 or TO2) the aircraft can potentially be exposed to a loss of directional control should the thrust levers be advanced past the scheduled limit in the event of an engine failure. This advice from the FCTM is correct as far as it goes … remembering that the 777 FCTM covers all types from the 777-200 through to the 777-300ER (*including the 777-200LR/F with its smaller body length and bigger engines*).

> BOEING — Takeoff and Initial Climb
> 777 Flight Crew Training Manual
>
> **Derated Takeoff Thrust (Fixed Derate)**
>
> Derated takeoff thrust (fixed derate) is a certified takeoff thrust rating lower than full rated takeoff thrust.In order to use derated takeoff thrust, takeoff performance data for the specific fixed derate level is required. Derated takeoff thrust is obtained by selection of TO 1 or TO 2 in the FMC.
>
> When using derated takeoff thrust, the takeoff thrust setting is considered a takeoff operating limit since minimum control speeds (VMCG and VMCA), stabilizer trim setting, and Minimum Takeoff Weight are based on the derated takeoff thrust. Thrust levers should not be advanced unless conditions are encountered during the takeoff where additional thrust is needed on both engines, such as a windshear condition.
>
> **Note:** If an engine failure occurs during takeoff, any thrust increase could result in loss of directional control. See the section titled "Engine Failure during a Derated Thrust (Fixed Derate) Takeoff" later in this chapter.

As an example, for the 777-300ER it turns out that at (very) light weights and low takeoff speeds utilising a fixed thrust de-rate such as TO2, the application of full TO thrust after an engine failure can theoretically place the aircraft at risk owing to the likely proximity of VMCG/VMCA. Since TO2 is based on a fixed de-rate (*Airline selected, for example 25%*) the takeoff speeds are selected against a reduced maximum TO2 based VMCG. Since neither thrust levers, nor the TO/GA switches are limited in any way by the employed TO1/TO2 limit – pilots needing extra thrust airborne may need to be careful.

However, for the 777-300ER it turns out that it's in a pretty tight corner of the envelope in which a pilot may experience this issue. While the figures shown here are representative only and must be re-evaluated for your conditions (*Aircraft Type/Engine Thrust Combinations; Varying Ambient Conditions, etc*) – it should be clear that this issue is only going to be encountered at very light weights – and for the specific case sample here, only on a wet runway. Basically, you'd need to be ferrying the aircraft empty without a lot of fuel on board either. Once again – your mileage may vary. However, given that typically the scenarios where an engine failure on takeoff needs extra thrust are usually high weight – pilots should consider the additional thrust above the employed TO1 or TO2 limit as available in an emergency in order to preserve a safe flight path.

B777-300ER		TO2 V2	TO1 V2	TO VMCA (x1.05)
Ferry Dry	(177 T)	128.9	144.0	128.9
Ferry Wet	(177 T)	**128.5**	136.5	**128.9**
Light Weight Dry	(186 T)	131.8	147.5	128.9
Light Weight Wet	(186 T)	131.8	136.6	128.9

9.13. Engine Stall & Surge – at Idle

The ❑ **Engine Lim/Surge/Stall** NNM checklist memory items sometimes complete with the engine at idle thrust and the engine still stalling/surging. Any further memory action by the crew (*prior to running the checklist*) should only be contemplated if flight safety is considered at risk. From the design of the checklist, Boeing clearly don't consider a stalling/surging engine at idle thrust a threat to flight safety or the checklist would continue the memory items to engine shutdown.

The technique of continuing the checklist by memory to **Fuel Control Switch** … **CUTOFF** to secure an engine that's stalling/surging at idle is not recommended unless the safety of the aircraft is at risk, which would be unusual for a surging/stalling engine at idle thrust. While the any stalling/surging engine at idle is not pleasant (*and bad PR, despite the excellent YouTube footage*), shutting an engine down from memory it not without its risks either. Complete the memory items as scripted, accelerate and clean up (*takeoff scenario*) and when clean/CON – then run the NNM checklist to secure the engine.

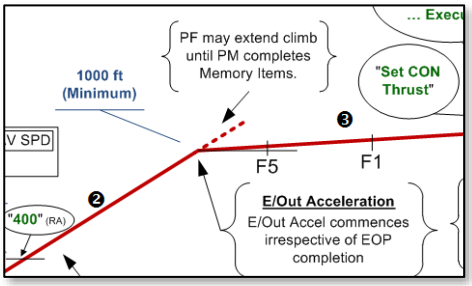
9.14. Engine Out Procedures – AIT

> **Engine Failure Procedure:**
> **TRK 340. At 5.0 DME ML RT TRK 130.**
> **AIT: TRK to EPP CLB MSA.**

The EOSID contains a documented EOP from the runway to MSA - in this case to track 340° to 5^{DME} ML VOR, then turn right and track 130°, climb to MSA. However, this guidance become invalid once the aircraft has departed from this track (*such as on the SID*) and subsequently has an engine failure. In this instance the AIT stands for After Initial Turn and refers to the path to be followed should the engine failure occur after the initial turn on the normal departure SID, in this case track direct to EPPing NDB and climb to MSA.

In principle, the PF/Captain should consider delaying acceleration and the associated flap retraction in this scenario to the MSA as terrain clearance is not guaranteed while following the AIT.

9.15. Acceleration, Configuration and Memory Items



It is not unusual for memory items associated with an engine fire/failure to carry past the acceleration height. The issue of 3rd segment acceleration during the running of checklist memory items can be a contentious one.

Typically, there are three options:

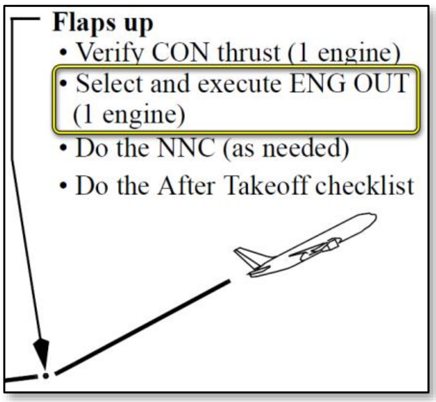
- Use VNAV Speed Intervention (or TOGA) to extend the second segment – ideally before the speed increase is selected by VNAV at the Engine Out Acceleration Height.
- Allow acceleration to commence, but delay configuring (*raising the flap*) until the memory items are complete. The aircraft will accelerate to the current Flap setting limit speed less 5 knots, then continue climbing.
- Allow acceleration to commence and re-configure on schedule, raising flap at the same time as Memory Items are actioned. Priority is typically given to appropriately actioning the Memory Items over the Flap Lever.

All of these options carry risk factors whether they be obstacle clearance, task prioritisation/workload issues or engine thrust time limit related. Crew must understand the risks of these procedures for dealing with acceleration during Memory Items and manage the risk appropriately. Decide early what your response will be and consider briefing it.

9.16. MSA vs SID/Cleared Altitude

In the event of an Engine Failure After Takeoff, it is not uncommon to see flight crew level off at the SID/ATC Cleared altitude after takeoff with little regard to the MSA in the direction of takeoff. This often occurs despite briefing to the contrary prior to departure. MSA/Terrain Clearance is a primary consideration once the aircraft is clean and the PF departs from the EOP.

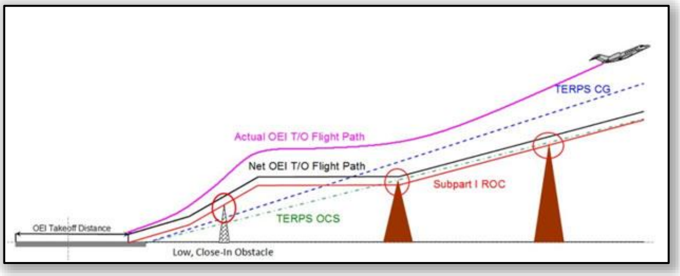
9.17. CON Thrust … VNAV ENG OUT



The Boeing FCOM/FCTM stipulates the selection of **<ENG OUT** on the CDU VNAV page once the Flaps are selected UP and CON thrust is set. This is a relatively new step, as traditionally the selection of VNAV - ENG OUT was left to the crew, who would usually only select it for diversions to ensure appropriate speed/altitude recommendations and predictions from the FMC for longer distance flying.

Selecting ENG OUT at this point will change the VNAV speed, typically increasing speed above UP speed to a higher value for climb to cruise. If this is not desired the selection of speed intervention by the PF prior to execution of the modification will retain speed control to the PF. When the PM is actioning the FMC VNAV ENG OUT – calling any changed altitude (*when above ENG OUT Maximum Altitude*) and the change in SPD is a good situational awareness promoting habit.

9.18. Engine Out SID's and E/GPWS Terrain Alerts



It must be appreciated that the clearance margins in a performance critical EFATO are not great. Commencing at approximately 35 ft, these margins are increased (*or decreased*) by gross/net gradient, performance decrement delta, local ambient conditions and other factors on the day.

It is therefore likely that when manoeuvring over/near terrain, particularly in the event of a non-standard engine out flight path – a GPWS terrain alert is a possibility – even a likelihood.

Any GPWS alert should cause the crew to re-evaluate their navigation and ensure they are following the promulgated engine out flight path from TLDC. The QRH GPWS Caution advisory would seem germane at this point "***Correct the flight path or the airplane configuration.***"

If on the promulgated EOP (*and in IMC*) then crew should not manoeuvre away from the EOP without very good cause. If in VMC then manoeuvring to clear terrain remains within the discretion of the Captain.

A GPWS Terrain Warning comes with a QRH injunction to fly manually straight ahead, pitching to 20°. It's probably safe to say this procedure doesn't necessarily allow for the full scope of a Terrain Warning during an EOP. Unless in VMC and able to manoeuvre clear of terrain, crew should consider following the EOP rather than tracking straight ahead – while following the other requirements of the Terrain Escape manoeuvre (*thrust, pitch (PLI), Speedbrake, etc*).

9.19. Engine In flight Re-Starts – Damaged Engines

Re-lighting an engine in flight contains some potential pitfalls that are worthy of discussion. Refer to the **Engine In Flight Start Envelope** for a discussion on the AFM assured-start operating envelope.

Eng In–Flight Start L, R

Condition: An engine start is needed and all of the following are true:
- There is N1 rotation
- There was **no** engine fire
- There is **no** abnormal airframe vibration

5 A restart may be attempted if there is N1 rotation and no abnormal airframe vibration.

6 Choose one:
- Restart **is** needed:
  - ►► **Go to step 7**
- Restart is **not** needed:
  - ►► **Go to step 13**

One discussion point is the result of recent changes in the Boeing QRH with respect to engine in flight starts. Traditionally the QRH would advise that re-start may be attempted if ***no indications of engine damage were present***. This has now been reduced to confirming N1 rotation, (*no fire in the case of the* ❑ **Eng In-Flight Start** Checklist) and no abnormal airframe vibration.

Based on this, a re-start could be attempted in the event of a frozen N2, zero oil pressure and a high engine vibration indication (*without associated airframe vibration*). Boeing's response to queries on this change was as follows:

- At low airspeeds typically associated with engine out operation, the N2 indication is not guaranteed and thus should not preclude a start attempt (**if needed**). The N2 rotor drives accessories which can drag the windmilling N2 indication below a reliable indication. An in-flight re-start attempt with a genuinely seized core (or fan) will only result in a failed start attempt.
- Similarly, Low Oil Pressure may be a normal indication with a failed engine and low forward airspeed. Very low oil quantity (*with accompanying low oil pressure*) may be an adequate reason to preclude a re-start attempt, but this would depend on the perceived **need** to re-start the engine.
- EICAS vibration indication alone does not necessarily indicate engine damage. Associated airframe vibration would be required, which should have led the crew to the ❑ **Eng Svr Damage/Sep** checklist instead without the option of a re-start.

In summary - the minimum requirement prior to attempting a re-start is that the engine is currently indicating neither Limit/Surge/Stall nor Engine Severe Damage/Separation conditions; no abnormal (*quite subjective*) airframe vibration and N1 rotation. From this point onwards, only the **need** to restart the engine is required. **Need** is a whole 'nother discussion.

9.20. CLB/CON Thrust during EFATO Acceleration

Occasionally during an EFATO sequence, CLB/CON thrust is unintentionally (*or intentionally*) set as the engine thrust limit prior to the aircraft being clean and having achieve **UP** speed. This can occur because the engine failure/shutdown occurs after VNAV engages CLB thrust or because FLCH is used inappropriately during the EFATO sequence. A similar situation can occur during engine out go-arounds.

There are various options to correct this situation:

- If CLB thrust set, the MCP CLB/CON switch should set CON thrust;
- The default FMC INIT REF page is THRUST LIM as this point, so pressing **INIT REF** ... **TO** (or **GA**) sets TO/GA thrust;
- The TOGA switches will clear all de-rates as well as returning the aircraft to **THR TOGA TOGA** modes.

The CLB/CON switch is a simple selection, but in the case of high weight or high de-rate take-off's, CON may not be enough thrust to guarantee adequate acceleration/terrain clearance.

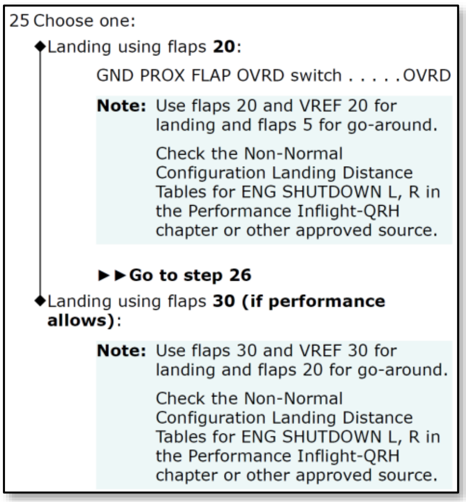
While TO/GA thrust can be set using the FMC CDU, this is usually an inappropriate time for FMC manipulation; mistakes are easily made.

The use of FLCH is regularly selected crew – FLCH is usually a save-all mode that sets an appropriate thrust limit, engages the A/Thr and corrects AFDS pitch mode anomalies as well. But it's not without its catches - the first issue is that FLCH will set what could be a thrust reduction – CLB or CON thrust (*see previous*). The second is that the aircraft will now be accelerating through the third segment in a mode that was never intended for the purpose. The FLCH 80/20 distribution of thrust for speed/altitude change may not meet the certification requirements of third segment acceleration (*which is designed to be essentially level*).

The correct response is usually the TOGA switches to re-engage TO/GA modes and TO/GA thrust. Lateral mode selection (LNAV? TRK SEL?) needs consideration as well as potentially a speed selection to either delay or continue/commence acceleration.

During an EFATO sequence or an engine out go-around without VNAV engaged, CON thrust should not be selected by the PF until the Flaps have been selected up and minimum clean speed (**UP**) has been achieved.

9.21. Deciding Where To Land – In The Middle of the NNM Checklist



25 Choose one:

◆Landing using flaps **20**:

GND PROX FLAP OVRD switch . . . . .OVRD

Note: Use flaps 20 and VREF 20 for landing and flaps 5 for go-around.

Check the Non-Normal Configuration Landing Distance Tables for ENG SHUTDOWN L, R in the Performance Inflight-QRH chapter or other approved source.

►►**Go to step 26**

◆Landing using flaps **30 (if performance allows)**:

Note: Use flaps 30 and VREF 30 for landing and flaps 20 for go-around.

Check the Non-Normal Configuration Landing Distance Tables for ENG SHUTDOWN L, R in the Performance Inflight-QRH chapter or other approved source.

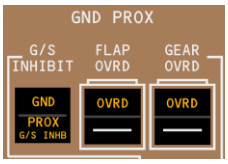
At some point in the engine malfunction NNM checklists, you are asked to decide between Flap 20 and Flap 30 for landing (see **Engine Out : Landing Using Flap 20 or Flap 30?**). As discussed, depending on your predilection towards dispute – usually both these selections are valid for most airports/runways. So … in our sensitive new age world, how do two pilots decided on an engine out flap setting when there's unlikely to be a clear determining factor one way or the other?

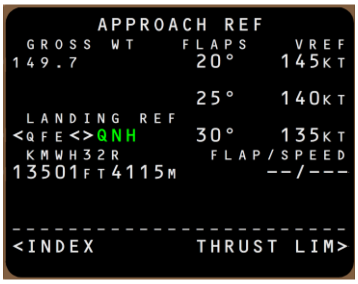
To make this decision properly, you really need to know which runway and missed approach climb requirement you are headed towards. By implication, that means you need to know the airport as well. Therefore, this means updating the weather, as well as reviewing NOTAMS and possibly approach plates and engine out landing and climb performance to make a considered, reasoned selection.

Whether you do this involved process or use one of the backup methods (*arm wrestling; toss a coin; Captain pulls rank*); the middle of the NNM checklist is not the time to do it. At this point, all the NNM checklist(s) are not complete; the Recall and Notes have not been reviewed; we are not in the phase of setting up for the approach. Just the simple addition later of an overweight landing into the mix can alter the Flap 20/30 decision. Therefore, this is an inappropriate time to commit to a runway / airport / flap setting.

But somehow you still have to get past this checklist item …

There's probably no simple, absolute answer to this conundrum other than an airline/training department policy (*or Boeing deferring the damn thing to the Approach Checklist*); but the initial selection of Flap 20 simplifies things somewhat if you then decide to land overweight, which <u>requires</u> Flap 20 if Engine Out.





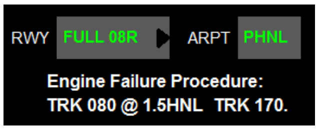
With NNM checklists complete, when you are setting up for the actual descent, approach & landing – crew are required to assess landing performance. At this point if the decision is changed to land Flap 30, this is actioned simply by selecting the appropriate flap setting/speed in the FMC. You should also consider reversing the selection of the GPWS Flap Override – failing to do so results in lowered configuration protection for the approach & landing (*but no actual procedural/performance impact*).

But this is a suggested technique – not a procedure.

Should the initial selection be Flap 30, but you later decide on Flap 20 – but failing to select the GPWS Flap Override switch will result in a configuration warning on final approach.

The procedure of re-running the relevant engine malfunction checklist from scratch and changing your answer to the Flap 20/30 question (*thereby generating the correct Note in the EICAS*) is <u>not</u> a recommended technique.

9.22. Engine Out Procedures Below 400 FT



On any takeoff – but particularly with an engine failure – the standard call "**Four Hundred**" is scheduled to remind the PF that it's time to think laterally. For an engine failure – this means compliance with the EOP and any FMA changes required to achieve this. But what happens when the EOP is so close to the end of the runway that a turn is required earlier – below 400 ft or even 200 ft AGL?

Note the following discussion includes suggested techniques only. If you find yourself headed for a takeoff at heavy weights with an early EOP turn – brief and agree on procedures with your PM; be specific; be thorough. I've chosen PHNL RW08R for this discussion and while the basics should hold true – every engine failure is different …

Comply with the EOP – Resistance Is Futile

The first thing to note is that once flight path control is established – the EOP is mandatory.

Commencing that turn overrides all considerations of AP engagement at 200 ft, and the lateral awareness call at 400 ft. If you don't turn when you're supposed to, you might not miss the hill – it's that simple.

So now we need to look at ways of complying with a low level EOP that works with the B777 AFDS …

Below 400 ft (Above 200 ft)

After an engine failure when the PM calls "**Four Hundred**" – with the aircraft under control, the PF should be thinking **Lateral Navigation**. Typically, this is "**Engage Track Select**."

While the SID is unlikely to satisfy the EOP forever – if the SID does overlay the EOP for a while then LNAV does a good job of keeping you on track – and bringing you back to track if you have wandered. Automatically calling "**Engage Track Select**" at 400 ft is not always the best policy. But having decided to stay with LNAV initially – be on guard for that point from which LNAV is following the all engine SID instead of the Engine Out SID.

But with an EOP that starts prior to 400 ft RA, lateral tracking needs to enter the picture earlier. Above 200 ft, even if the AP isn't engaged – the flight path and control issues of the engine failure should be sorted. It is then be fairly simple to either reach up and engage Track Select (*AP Engaged*); or call for Track Select and the desired Track (*anytime*). If it's pre-set, it's even easier …

Otherwise the option remains to simply commence a turn as you reach the point at which the turn must commence (*in this case, 1.5 DME from HNL VOR*). The horizontal Flight Director provides good guidance for speed (*V2 … V2+15*); but you'll have to ignore the vertical FD bar for the moment and just steer the required Track. Obviously, this has to be hand flown and the Autopilot is not available to you, at least initially.

Below 200 ft

Here is where things get interesting and care must be taken (*notice how being low to the ground does that?*).

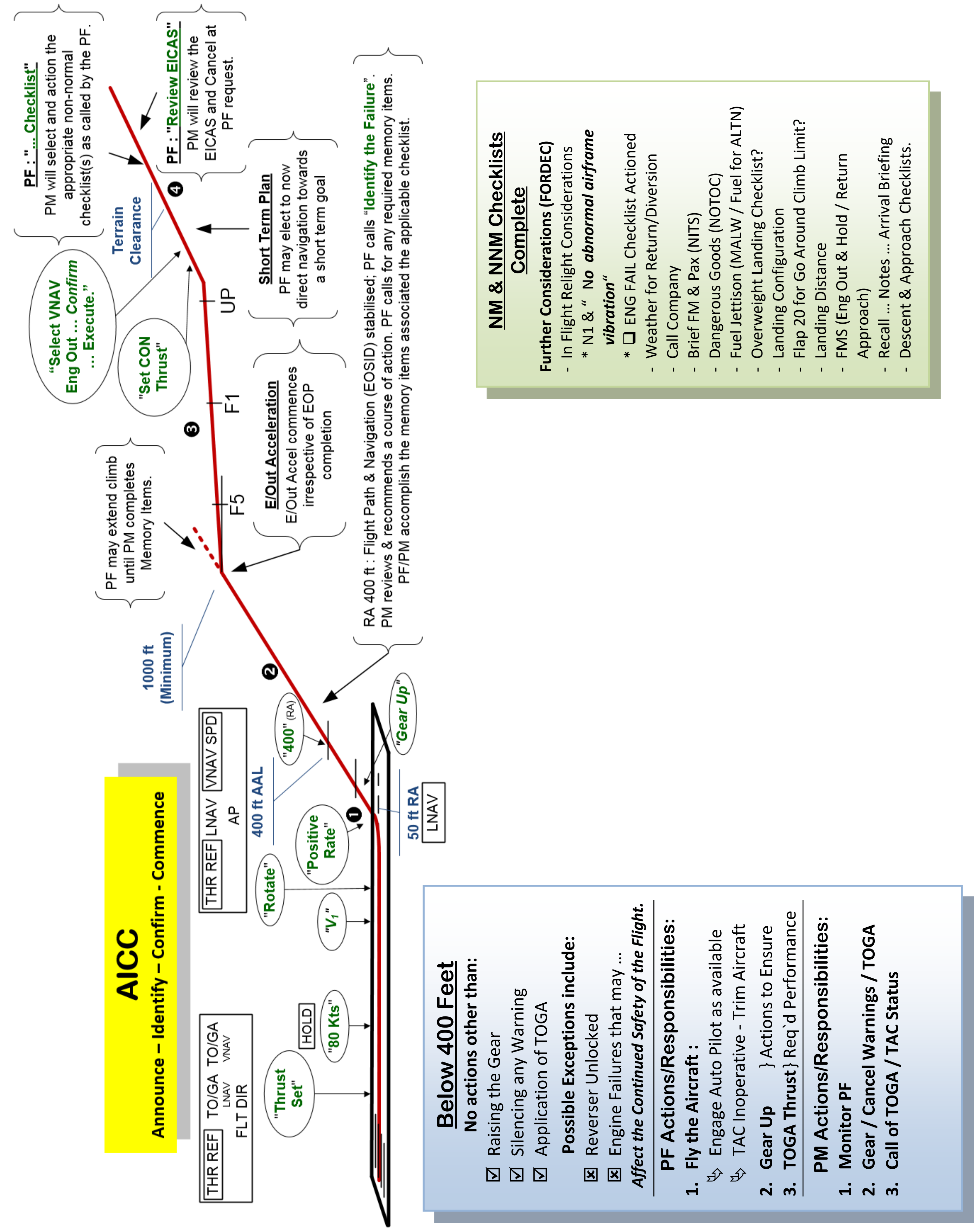
With the autopilot not available – you're also very low to the ground to be distracting the PM by calling for AFDS mode engagements and track bug changes. With a couple of practice goes, crew achieve this high degree of implicit understanding and communication fairly easily in the simulator – but when are you ever going to get practice at this just before you're required to do it? Briefing it might help …

Below 200 ft with the requirement to turn shortly after an engine failure on takeoff, the priority is – **Fly The Aircraft**. Don't commence the turn until flight path is under control – **Adequate Rudder**, **Pitch Attitude**, **Thrust, Speed** & **Positive Climb**. Nothing degrades a badly handled loss of thrust where you're trying to sort the rudder quite like starting a turn …

Having achieved this – once again, maintaining pitch (*horizontal FD bar should be giving good guidance at this point*) and starting a gentle turn (*15° AoB or whatever is required*) towards the desired track is usually the simplest, lower risk solution to your immediate problem, rather than introducing the potential confusing of MCP calls and FMA mode changes at low altitude (*height above ground!*)

9.23. Engine Failure on Takeoff – Overview Diagram

This diagram overviews a sequence profile for Engine related NNM's during takeoff and must not be extrapolated across the spectrum of other takeoff NNMs or other phases of flight – refer to the Boeing FCTM/ QRH.



Engine Failure on Takeoff Diagram Notes

- Between A/Thr **HOLD** and lift-off, only manual advancement of thrust is available. Once airborne the TO/GA Switches are available. It is acceptable to push the thrust levers forward below 400ft to increase thrust and still preserve LNAV/VNAV engagement. The A/Thr re-engages at 400 ft AAL if VNAV engages and re-sets any de-rated takeoff thrust.
- PM may call "**Engine Problem**" or the relevant EICAS message during takeoff – however nothing should prejudice the requirement for "**Rotate**" and "**Positive Rate**" from the PM.
- If performance is marginal and PF is struggling with flight control, PM can consider a call of "**TOGA Thrust Available**" at an appropriate time.
- If the PF is observed to be trimming with TAC available, a call of "**TAC is Available**" can be a helpful reminder not to trim / or to cancel any manual trim inputs.
- AP engagement is strongly encouraged above 200 ft with flight path and performance stabilised. The aircraft does not have to be trimmed but ***should be In Trim*** before AP engagement.
- Apart from rudder pedal feedback, TAC failure will be indicated by EICAS after the takeoff inhibit ends. If the aircraft is accidently trimmed with TAC engaged, use of the Manual Trim Cancel Switch will remove **pilot** trim inputs.
- The correct technique for trimming achieves Control Wheel Neutral, with a slight angle of bank towards the live engine.
- TOGA Thrust should applied as required for flight path and performance, by the PF. PM may suggest as appropriate. While FMA **HOLD** is active, the thrust levers can be moved forwards by the PF without TOGA Switch use.
- If TOGA lateral tracking is incorrect, one option is to steer the required track and re-select TOGA. Note this will deselect LNAV/VNAV arming/engagement.
- The "**400**" ft (RA) call is a ***lateral awareness call***. During EFATO this call serves to remind the PF to consider the EOSID and the APFD modes required to follow them – such as runway track/track select when the normal departure LNAV/SID requires otherwise.
- EOP/EOSID Navigation takes priority over failure assessment and checklist/memory items.
- The AFDS limits bank angle engine out (HDG/TRK SEL in AUTO) to 15° until V2+10 kts, then increases to 25° at V2+20 – unless in LNAV. If full manoeuvring is required in HDG/TRK Select, the bank angle selector must be utilised to increase the limiting bank angle.
- Engine Out Procedures are based on still air, speed between V2+15 and 200 Kts, with an angle of bank varying with increasing airspeed above V2+15. The EOSID is commenced irrespective of achieving engine out acceleration height, depending on EOSID specification.
- Engine Out Acceleration takes place at a minimum of 1000 ft AAL, or higher as specified by takeoff performance calculation. Second Segment climb can be extended in order to complete checklist memory items – see **Acceleration, Configuration and Memory Items**
- The second segment (❷) can be extended using Speed Intervention. Remember to cancel Speed Intervention when any Memory Items are complete.
- TOGA thrust is limited to 10 minutes from EGT above 1050°C (CON Thrust). Also Max (N1 %110.5 or N2 %121.0) [AFM, GE90]
- If the 10-minute thrust limit is reached, CON thrust can be selected in order to avoid exceeding certified thrust limits, terrain permitting.
- **CON** thrust is not set until Flaps are **selected** Up and VREF 30+80 (**UP** speed) reached. In basic modes use **FLCH** or A/Thr **CLB/CON** switch.
- Crew should consider terrain clearance before commencing a sequence of NNM checklists. However, this does not require reaching MSA or LSALT prior to continuing with the NNM.
- The "Short Term Plan" is used to manage short term flight path and navigation requirements between Clean/CON and completion of the NNM checklists. Typically, the short term plan will conform to that briefed during the Departure Briefing and cover items such as immediate tracking/altitude requirements, any likely need to hold/jettison and general intent of destination. NNM checklists NOTES may well change these considerations.

9.24. Engine Out : Landing Using Flap 20 or Flap 30?

Several NNM checklists ask the crew to decide between a Flap 20 or Flap 30 landing when the NNM results in a reduction/loss of thrust from an engine. The times when you will find yourself having to answer this question include:

- ❑ FIRE ENG ❑ Eng Svr Dam/Sep ❑ Eng Lim/Surge/Stall ❑ ENG FAIL
- Also : Engine Oil Pressure/Temperature; Engine Overheat; Fuel Leak/Flow problems; Bleed/Anti-Ice Leak.

Choose one:

◆Landing using flaps **20**:

GND PROX FLAP OVRD switch . . . . .OVRD

Note: Use flaps 20 and VREF 20 for landing and flaps 5 for go-around.

Check the Non-Normal Configuration Landing Distance Tables for ENG SHUTDOWN L, R in the Performance Inflight-QRH chapter or other approved source.

◆Landing using flaps **30 (if performance allows)**:

Note: Use flaps 30 and VREF 30 for landing and flaps 20 for go-around.

Check the Non-Normal Configuration Landing Distance Tables for ENG SHUTDOWN L, R in the Performance Inflight-QRH chapter or other approved source.

Fundamentally this is a decision relating to aircraft performance across two main aspects – Missed Approach Climb and Landing Distance. An additional consideration can be brake cooling in relation to the faster touchdown speed of Flap 20 which is typically not a consideration in a NNM.

Missed Approach Climb is traditionally considered more critical - the loss of 50% of your thrust and nearer 80% of your climb performance is the clear winner compared to the average 20% increase in landing distance between Flap 30 and Flap 20. But that depends on how short your runway is; and how big the hill at the end …

In a fly by wire aircraft the "feel" of a Flap 20 landing should be similar to Flap 30, and with several airlines regularly conducting Flap 25 – a comparison of the issues of Flap 20 vs Flap 30 selection does not require references to "feel" or "float".

In terms of performance … you have two somewhat conflicting requirements here.

From the Dark Ages …

In the dim distant past the option to land OEI Flap 30 brought with it a requirement to ensure "*performance permitting*"; selecting Flap 20 had no such restriction.

The focus of the NNM checklist was missed approach climb and while your gradient had to be checked for a Flap 30 landing – it did not for Flap 20, hence Flap 20 became the "default" selection.

These days you have to check your performance for every selection, and this includes consideration of Landing Distance as well as Missed Approach Climb.

OEI Missed Approach Climb Performance – Flap 20 vs Flap 30

The use of Flap 30 for an OEI Landing brings with it the drag of Flap 20 in the go-around (vs Flap 5). Boeing provide two charts to reference here. The first is the "Landing Climb Limit Weight" which covers **two** separate performance requirements:

- **Landing Climb Limit Weight** : All engine, Landing Flaps and Gear remain extended;
- **Approach Climb Limit Weight** : Engine Out, Landing Gear Retracted, One stage of Flap Retraction (*typically limiting*).

The point to note is that in terms of pressure altitude and temperature, unless you are well above maximum landing weight – you're very unlikely to be limiting. Meanwhile additional charts for non-standard missed approach climb gradients of up to 5.5% indicate that again, until you are well above maximum landing weight, performance is not limiting.

Gear Stays Down?

Boeing recently slipped a comment into the explanatory text for QRH Performance Inflight, indicating that when crew are checking performance for an engine inoperative landing, they should check **rate of climb capability** in **Gear Down Landing Rate of Climb Available** tables – effectively to determine how you'll go if the gear doesn't come up on the engine out go-around.

Performance Inflight - QRH 777-300ER/GE90-115BL
Text FAA
777 Flight Planning and Performance Manual Category B Brakes

Advisory Information

Non-normal Configuration Landing Distance

…

For an engine inoperative landing, check the rate of climb capability shown in Gear Down Landing Rate of Climb Available tables to ensure adequate climb performance.

If your landing gear doesn't retract after an OEI approach – you aren't going anywhere if you flew a Flap 30 into Flap 20 go-around. But at that point you're clearly having a very bad day. This is not a regulatory requirement (*unless you have reason to believe your landing gear won't retract*), it's for awareness only – but it does tend to drive you (*rightly or wrongly*) to a Flap 20 landing flap selection, landing distance permitting.

OEI Landing Performance – Distance

Meanwhile a lot more data is provided when you look to compare Flap 30 landing distance vs Flap 20. Quite apart from a comparison of OEI Autobrake 2/3/Max/Max Manual; there is some validity to looking at All Engine Flap 20 vs Flap 30. After some extensive analysis, it turns out that the selection of Flap 20 over Flap 30 for an autobrake landing brings with it an increase in landing distance used by about 20%. This figure is valid for increases in Weight, Altitude Wind Component, Temperature and Slope (*within reasonable limits*). It's less valid for Max Manual braking – but if you're contemplating a Max Manual Braking landing, you're probably not choosing to do so Flap 20.

Engine Out Flap 20/30 - Summary

In the modern age, you should always be directed to know/check your performance … in the absence of a clear performance limit driving you towards one flap selection …

- If you are contemplating a landing on a short runway – you should probably be using Flap 30.
- If you are looking at an approach with a steep missed approach climb gradient – you should probably be using Flap 20.
- If you are going to landing on a very short runway with a big hill at the end – ask yourself, "**Why am I doing this?**"

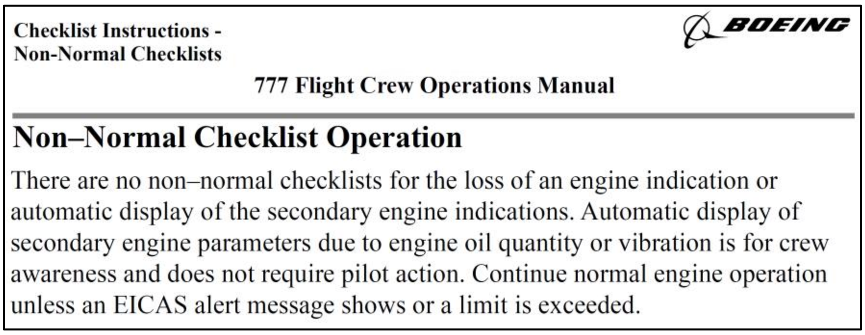
Boeing have advised that a "default" checklist selection of Flap 20 is a valid one – to be revisited once the airport, approach and runway have been confirmed. Since the final airport selection usually comes well after the checklist – this is not a bad default. But it's a **Technique** – not a Procedure.

Flap 20 -> Flap 30 Reversion

Having decided on a default Flap 20 setting for your engine out approach, if a reversion to Flap 30 is required (*for example – runway change to a performance limited landing distance solution*) the following changes need to be actioned:

- **GND PROX FLAP OVRD** switch … **OVRD** is required for Flap 20 (but not for Flap 30)
- **CDU INIT REF APPROACH** … VREF Flap/Speed will need updating
- Performance Assessment ➔ Autobrake Selection ➔ Runway exit point (update Brief)
- Revise Go-Around Actions "**Ok, so now it's going to be 'Go-Around, Flap 20**".

9.25. Engine Vibration


Checklist Instructions -
Non-Normal Checklists

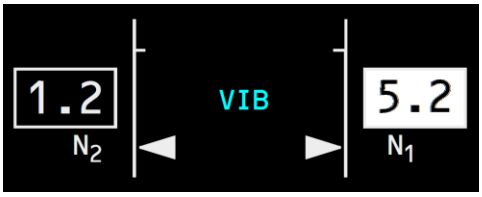
777 Flight Crew Operations Manual

Non–Normal Checklist Operation

There are no non–normal checklists for the loss of an engine indication or automatic display of the secondary engine indications. Automatic display of secondary engine parameters due to engine oil quantity or vibration is for crew awareness and does not require pilot action. Continue normal engine operation unless an EICAS alert message shows or a limit is exceeded.

Not all Engine Malfunctions are as clear as ❑ ENG FAIL, ❑ FIRE ENG or even Engine Failure Analysis. Sometimes engine malfunctions are as simple as anomalous indications of Oil Temperature or Pressure – or high engine vibrations on the Secondary Engine Display.

Engine VIBrations (*like other secondary engine indications that do not have actual flight manual limitations – such as Oil Quantity*) do have a highlight feature when the indications are to be considered unusual. Above a certain value (*don't tell anyone – it's 4.0*) – the display inverts, black text on white background. If not already displayed this will automatically pop up the secondary engine indications on the lower MFD / compacted EICAS display.



There have been times in the past when crew have (*and have been trained to*) action a precautionary engine shutdown in response to single indications such as high vibration or low oil quantity.

The QRH is however quite clear. Such indications – including the automatic display of secondary engine indications – are not enough on their own to require shutting down the engine. You need some other kind of corroboration of an engine problem – a limit exceedance of one of the other parameters puts the situation beyond doubt – to go down the somewhat radical path of shutting down half your available engines.

Note that even mild airframe accompanying vibration (*such as would be felt with a high N1 VIB indication – but not necessarily with N2/N3*) might not be enough to require you to secure the engine. There's clearly something wrong – but you are not required to do anything about it other than perhaps consider a reduction of thrust to see if that contains the problem.

Most airlines will specify a value of continued EICAS VIB indication that should be reported in a Technical Log. Again – don't confuse this administrative requirement with a need to take action against an engine that is otherwise delivering thrust.

Finally, airline and manufacturer documentation often refer to vibration as an indication of engine damage or otherwise unsuitability for continue operation. Read carefully – in my experience these references are usually to ***airframe vibration*** rather than EICAS Secondary VIB indications.

10. Normal Operations Flows

10.1. Before Start Flow

Before Start Flow

Prior to Flow

- Doors Closed, Flight Deck ready for Push/Start; CA contacts Gnd Eng for clearance to Pressurise Hydraulics (Gnd Eng confirms)
- CA calls "**Cleared to Pressurize**"
- FO commences flow, then runs "**Before Start Checklist to The Line**"
- FO obtains ATC Push/Start; Complete Before Start Flow.
- CA advises the Gnd Eng we are cleared Push/Start.

CA Flow

FO	*3. EICAS*	*"Recall ___"*
CA	"**Cancel EICAS**"	
CA	Trims (x3)	Set
CA	4. Call For . . "**BEFORE START CHECKLIST**"	

FO Flow

1. Hydraulic Panel . . . . Set
2. Fuel Panel . . . . Set
3. DSP EICAS RECALL . . . . Press
4. DSP CHKL button . . . . Press

When CA calls for it, accomplish BEFORE START CHECKLIST to The Line

5. ATC Push/Start Clearance . . Obtain
6. Radios 121.5/Data
7. Transponder . . . . TA/RA
   - Ensure TFC displayed on ND

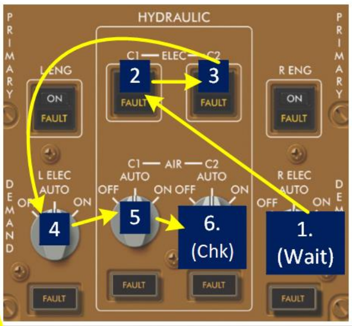
8. Beacon . . . . ON

BEFORE START CHECKLIST . . Complete

8. DSP Secondary ENG . . . . Display

Hydraulic Panel ... Set

1. Wait for the FAULT light to extinguish
6. Verify Before Engine Start :
   - C1 ELEC PRI FAULT light . . . . Clear
   - C1&C2 AIR DEMAND FAULT lights . . Clear

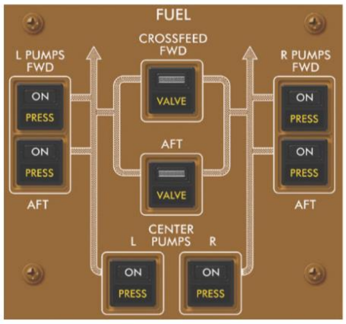


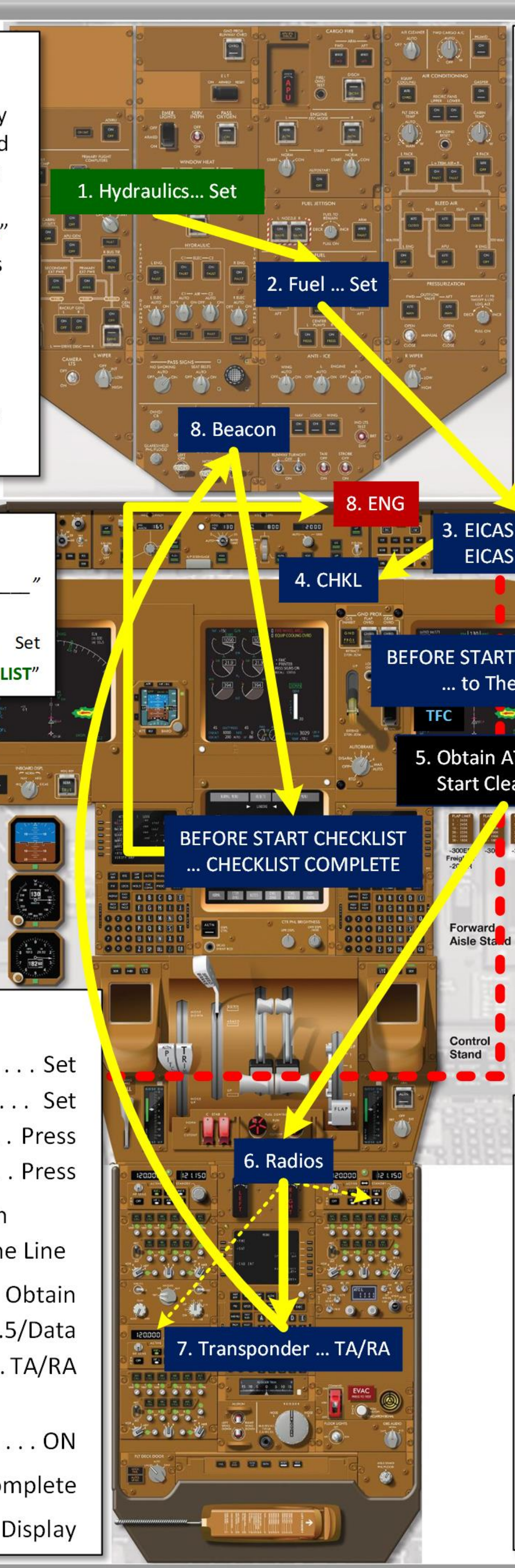
2. Fuel . . . . Set

L+R FWD+AFT Main Tank Pumps . . . ON

If EICAS **FUEL IN CENTER** displays ...

- L+R CENTER PUMPS . . . . ON



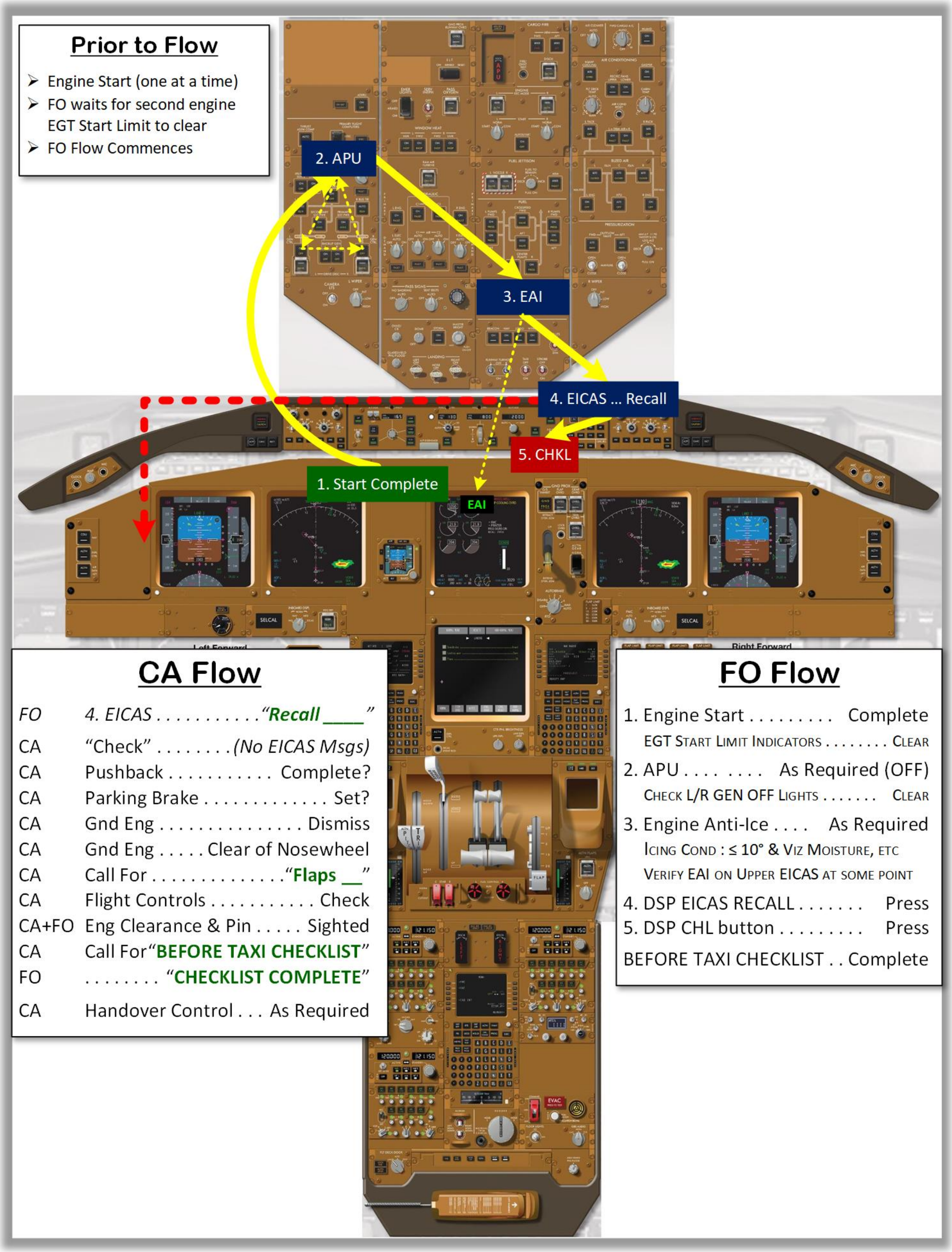


10.2. After Start Flow

After Start Flow

Prior to Flow

- Engine Start (one at a time)
- FO waits for second engine EGT Start Limit to clear
- FO Flow Commences



CA Flow

FO	*4. EICAS . . . .*	***"Recall ____"***
CA	"Check"	*(No EICAS Msgs)*
CA	Pushback	Complete?
CA	Parking Brake	Set?
CA	Gnd Eng	Dismiss
CA	Gnd Eng	Clear of Nosewheel
CA	Call For	**"Flaps __"**
CA	Flight Controls	Check
CA+FO	Eng Clearance & Pin	Sighted
CA	Call For	**"BEFORE TAXI CHECKLIST"**
FO	. . . .	**"CHECKLIST COMPLETE"**
CA	Handover Control . . .	As Required

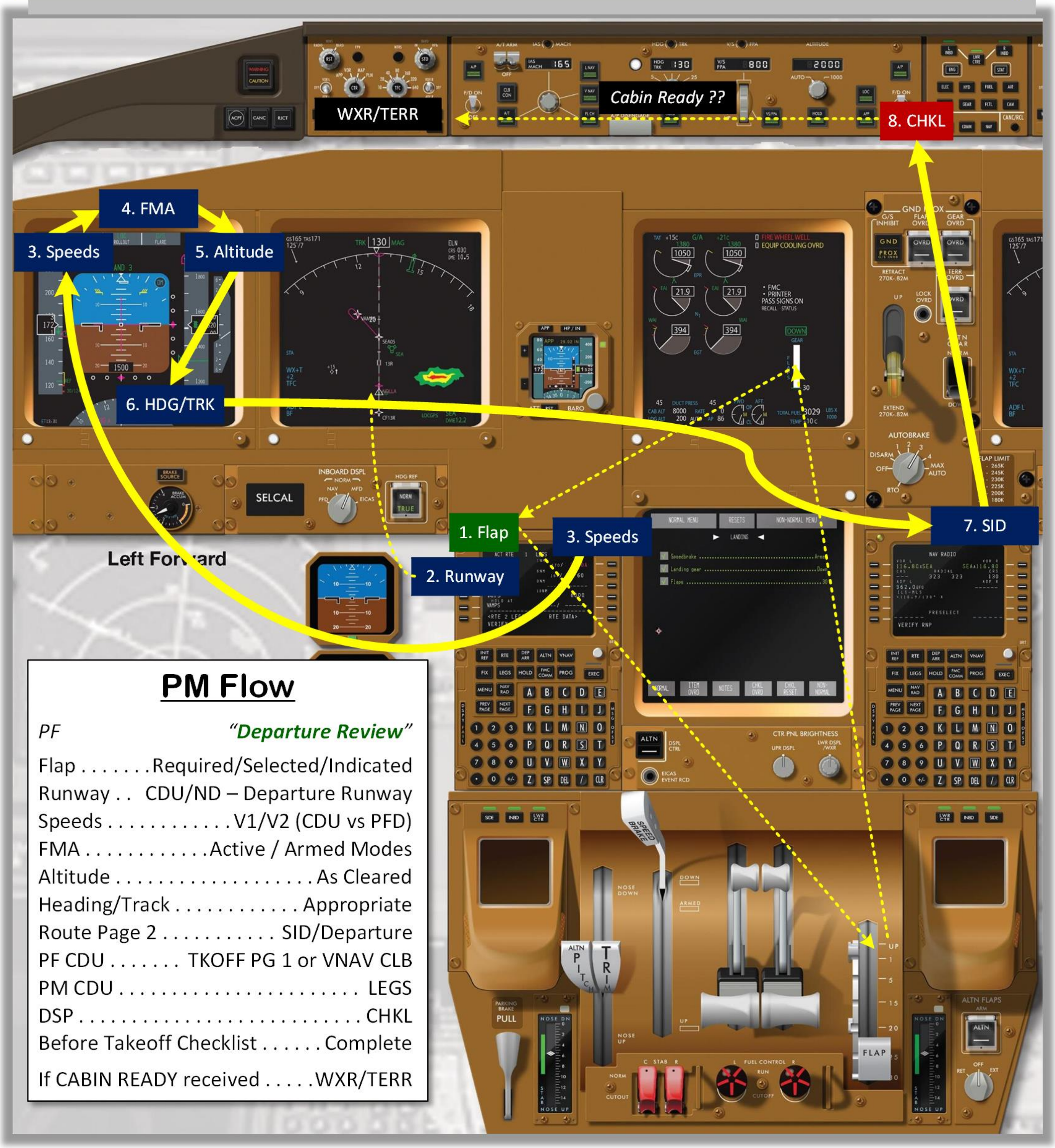
FO Flow

1. Engine Start . . . . Complete
   EGT START LIMIT INDICATORS . . . . CLEAR
2. APU . . . . As Required (OFF)
   CHECK L/R GEN OFF LIGHTS . . . . CLEAR
3. Engine Anti-Ice . . . . As Required
   ICING COND : ≤ 10° & VIZ MOISTURE, ETC
   VERIFY EAI ON UPPER EICAS AT SOME POINT
4. DSP EICAS RECALL . . . . Press
5. DSP CHL button . . . . Press

BEFORE TAXI CHECKLIST . . Complete

10.3. Departure Review Flow

Departure Review



PM Flow

PF	***"Departure Review"***
Flap	Required/Selected/Indicated
Runway	CDU/ND – Departure Runway
Speeds	V1/V2 (CDU vs PFD)
FMA	Active / Armed Modes
Altitude	As Cleared
Heading/Track	Appropriate
Route Page 2	SID/Departure
PF CDU	TKOFF PG 1 or VNAV CLB
PM CDU	LEGS
DSP	CHKL
Before Takeoff Checklist	Complete
If CABIN READY received	WXR/TERR

10.4. After Takeoff Flow

After Takeoff Flow

PM Flow

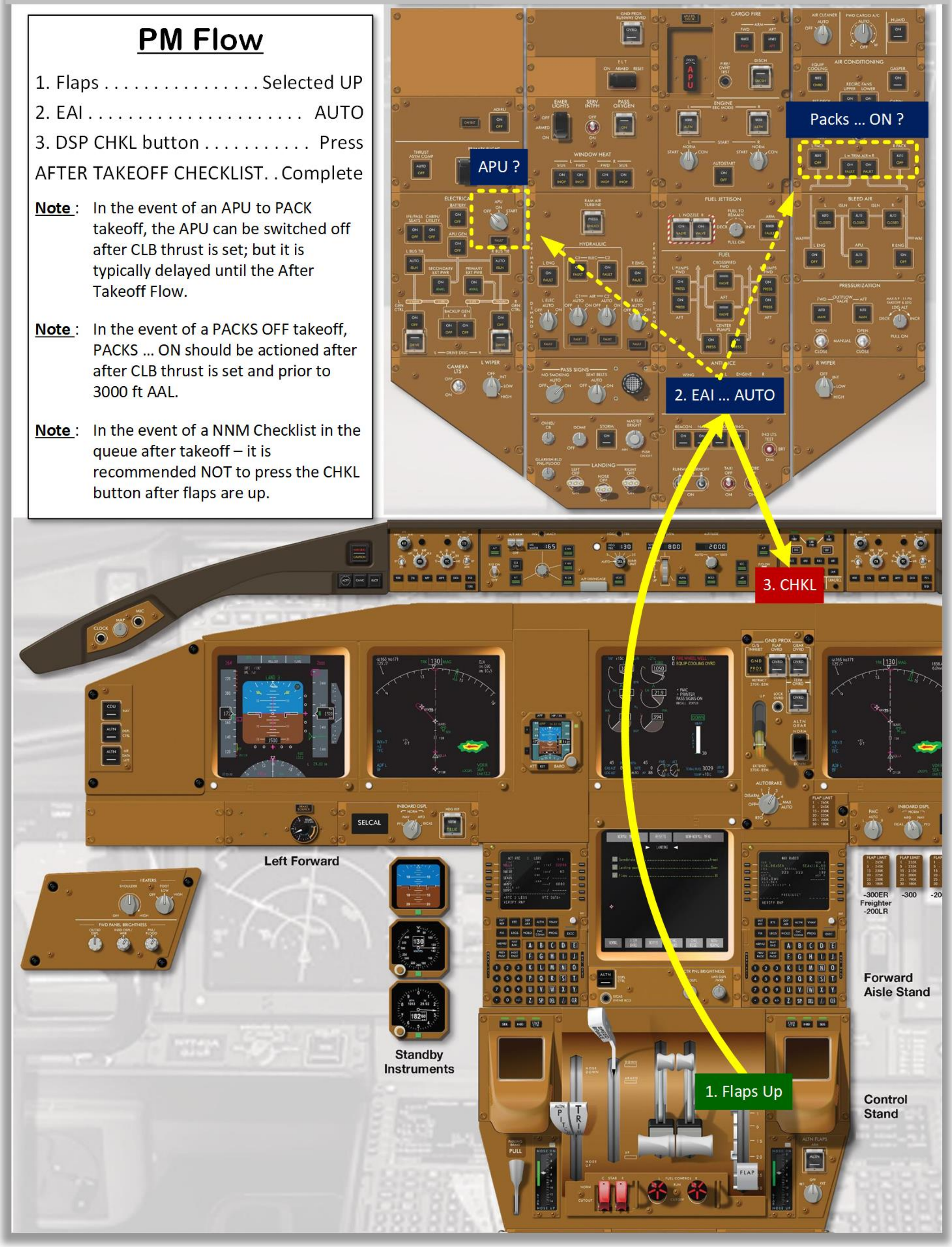
1. Flaps . . . . Selected UP
2. EAI . . . . AUTO
3. DSP CHKL button . . . . Press

AFTER TAKEOFF CHECKLIST. . Complete

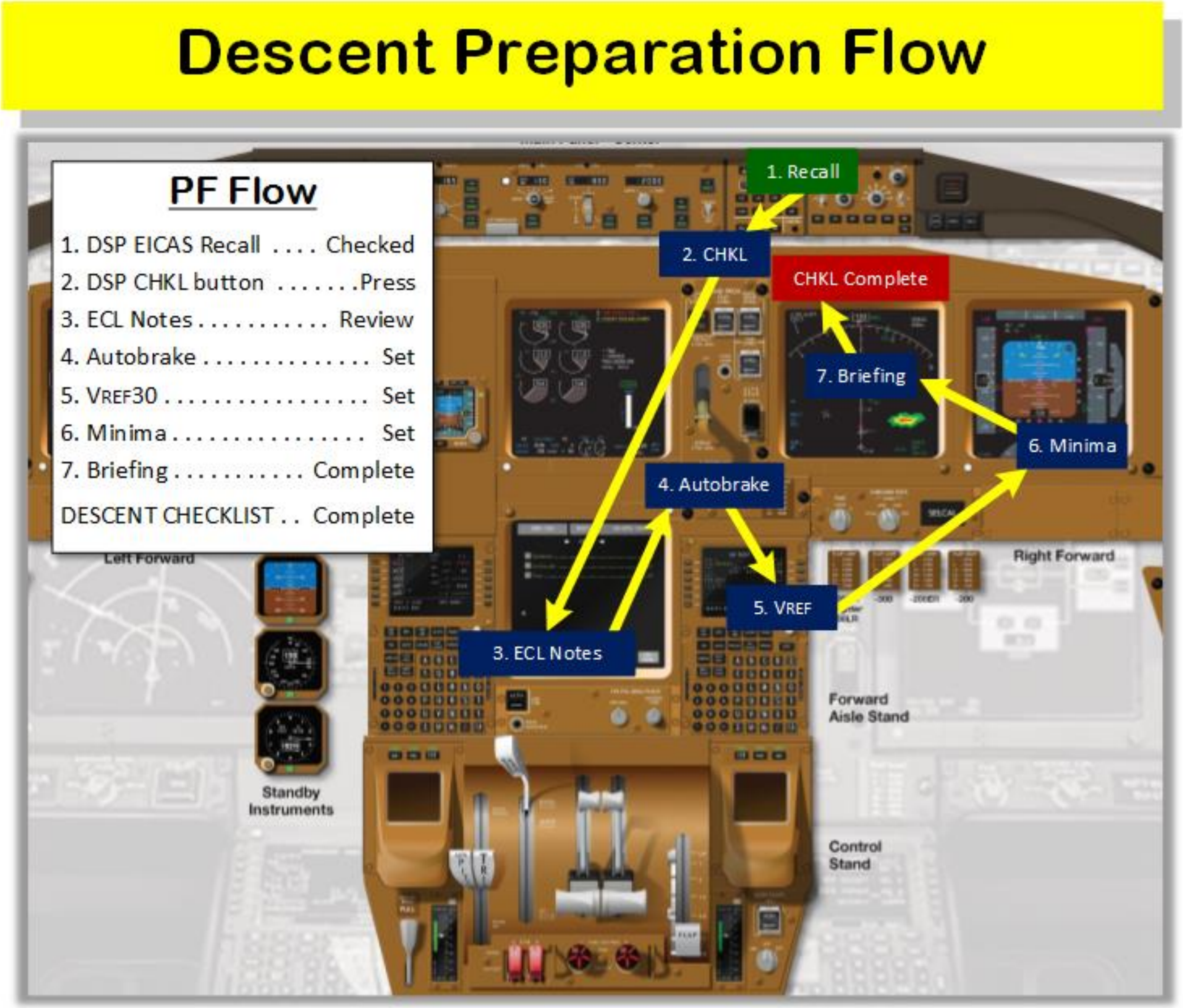
Note : In the event of an APU to PACK takeoff, the APU can be switched off after CLB thrust is set; but it is typically delayed until the After Takeoff Flow.

Note : In the event of a PACKS OFF takeoff, PACKS ... ON should be actioned after after CLB thrust is set and prior to 3000 ft AAL.

Note : In the event of a NNM Checklist in the queue after takeoff – it is recommended NOT to press the CHKL button after flaps are up.

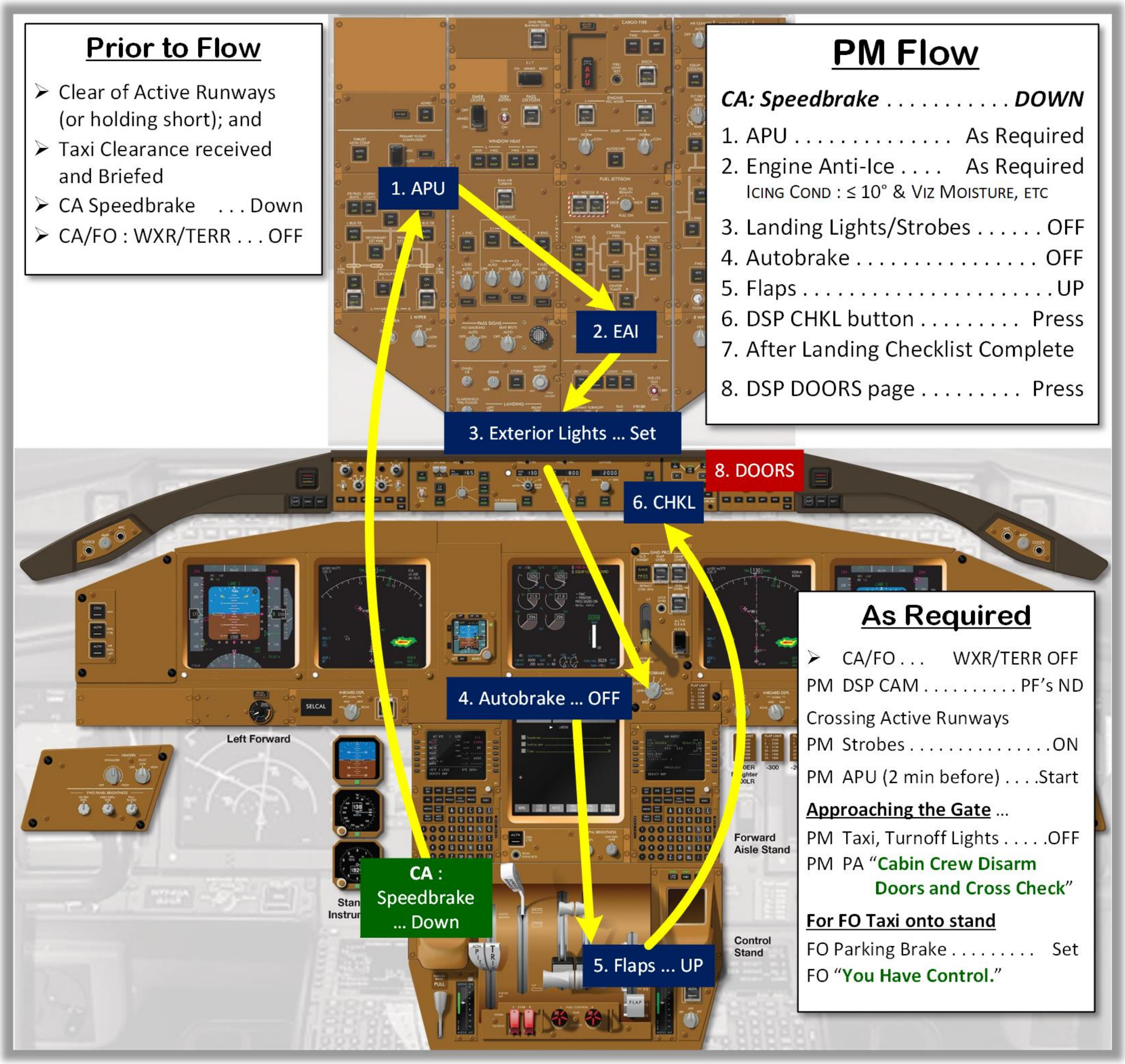


10.5. Descent Preparation Flow



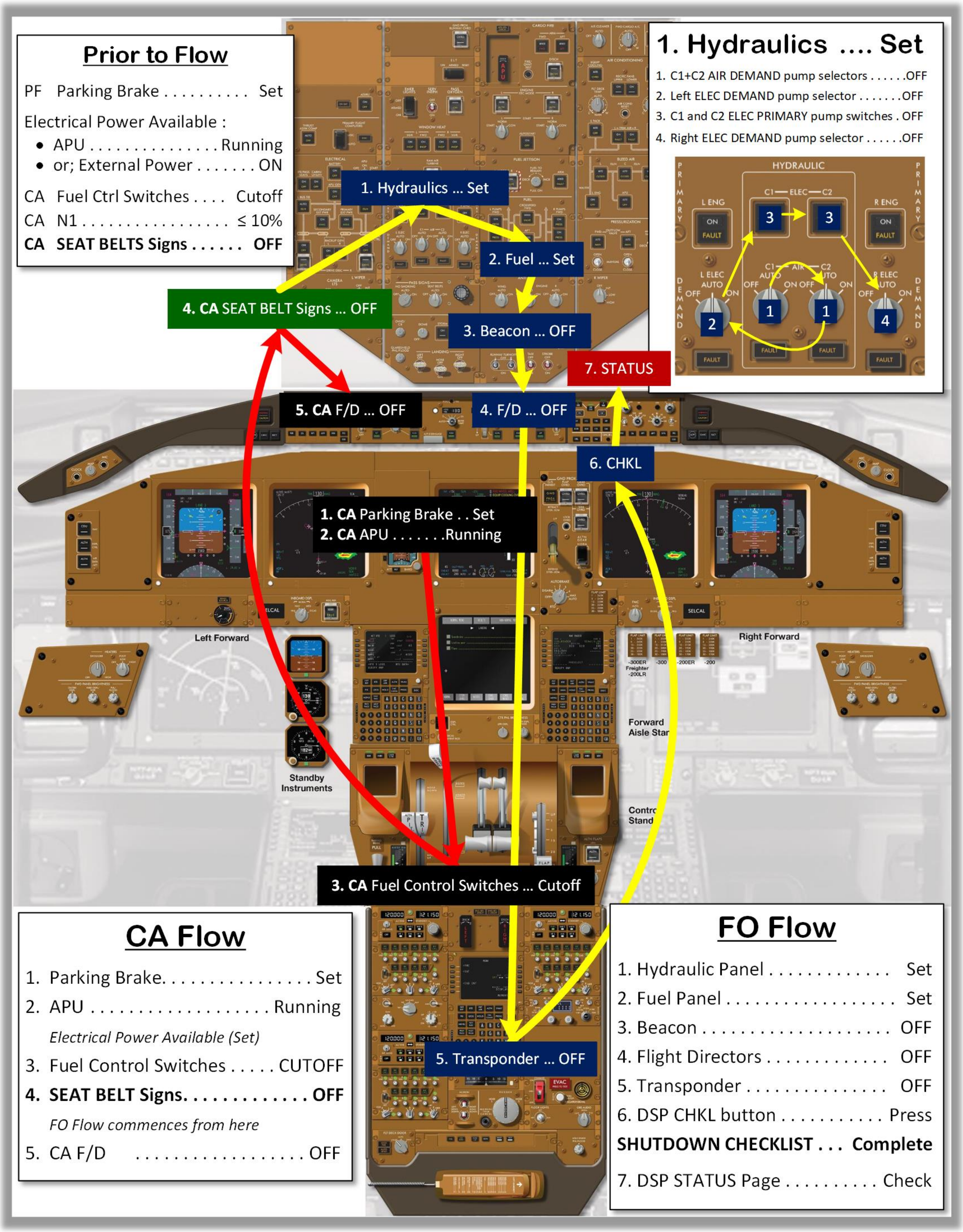
10.6. After Landing Flow

After Landing Flow



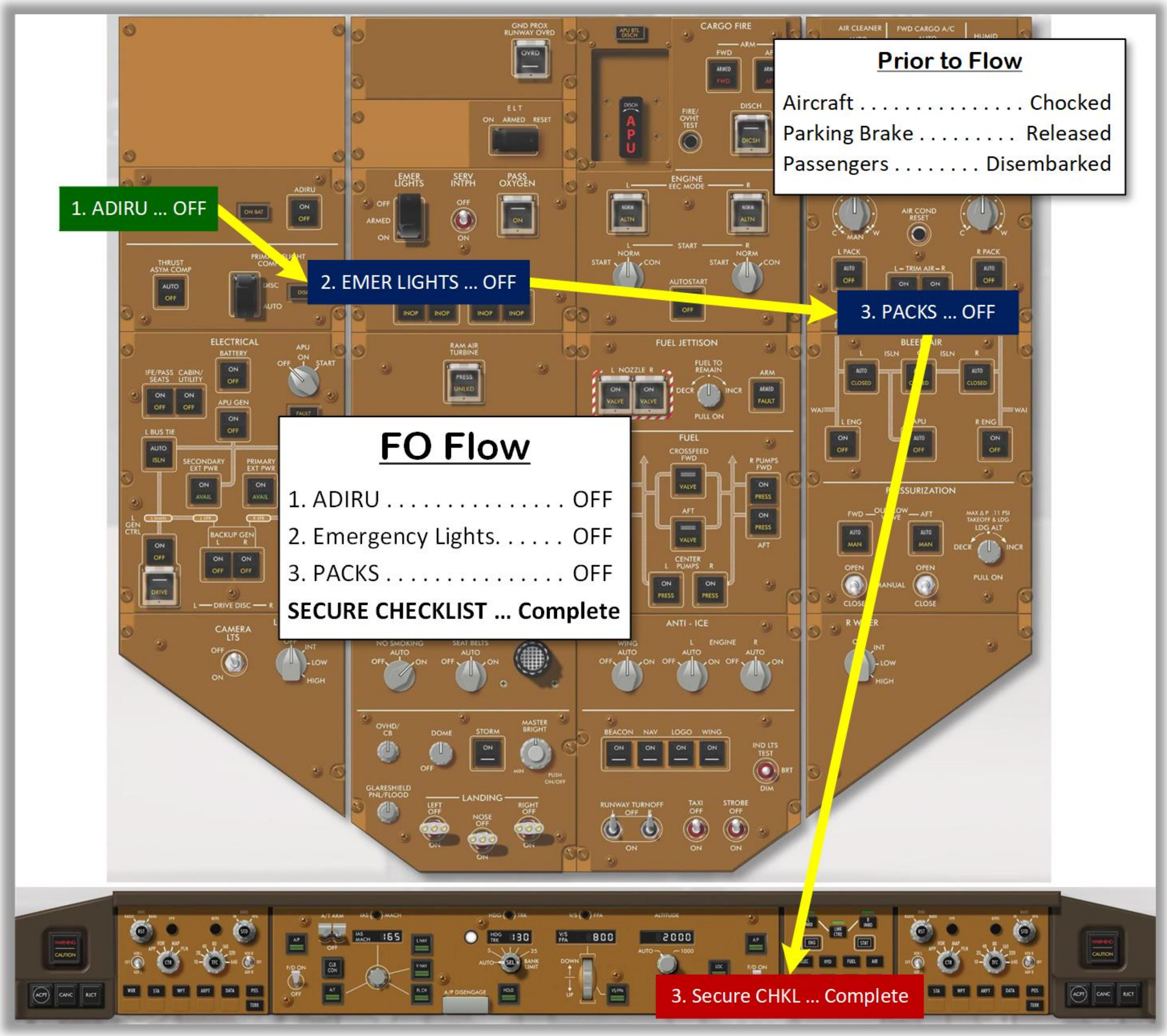
10.7. Shutdown Flow

Shutdown Flow



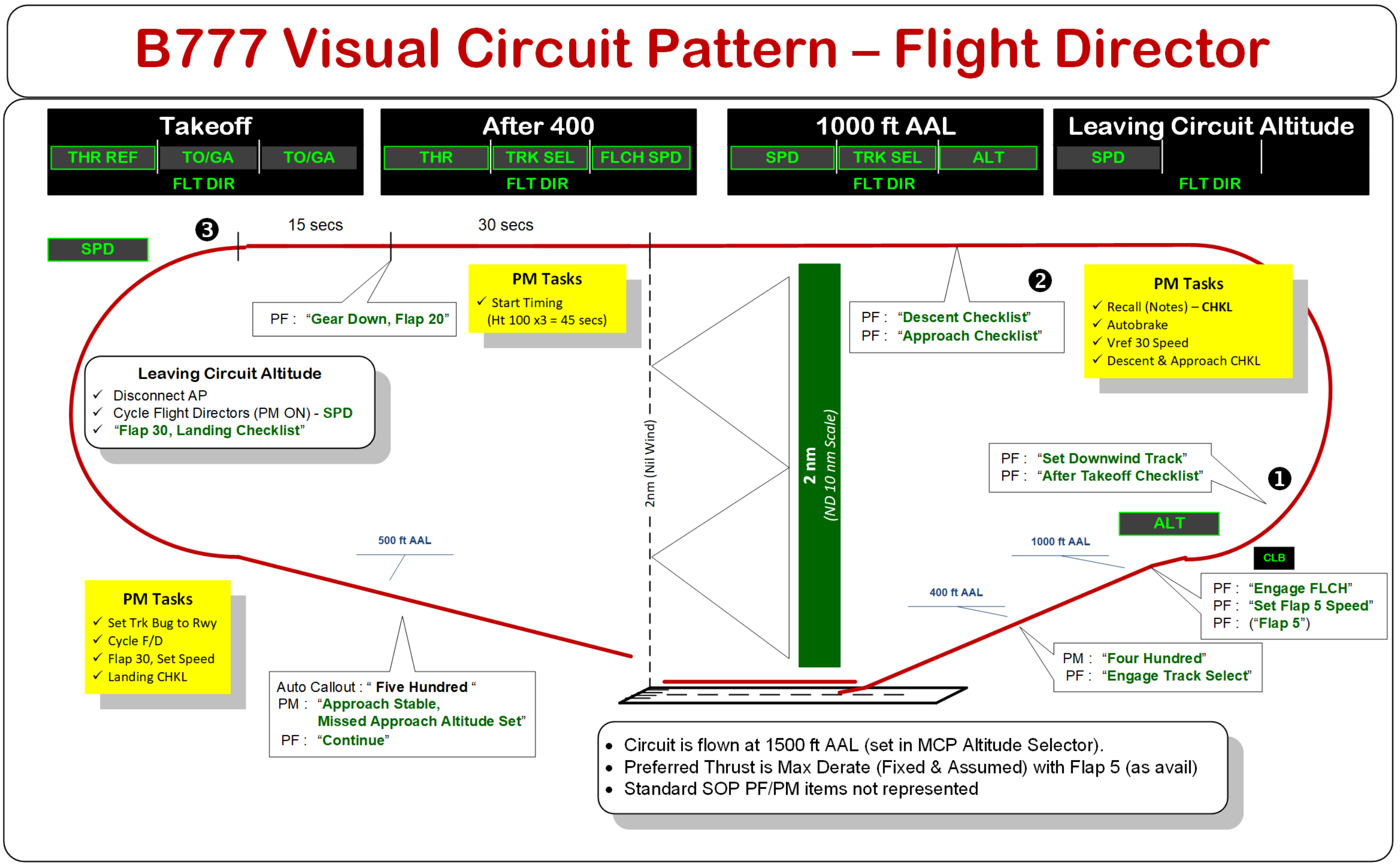
10.8. Secure Flow

Secure Flow



10.9. Circuit Pattern – Flight Directors ON

Circuits are typically flown in the simulator to improve scan pattern and hand flying skills using both Flight Directors and Raw Data. Below is a standard pattern to ensure adequate spacing and procedural consistency when conducting circuits.



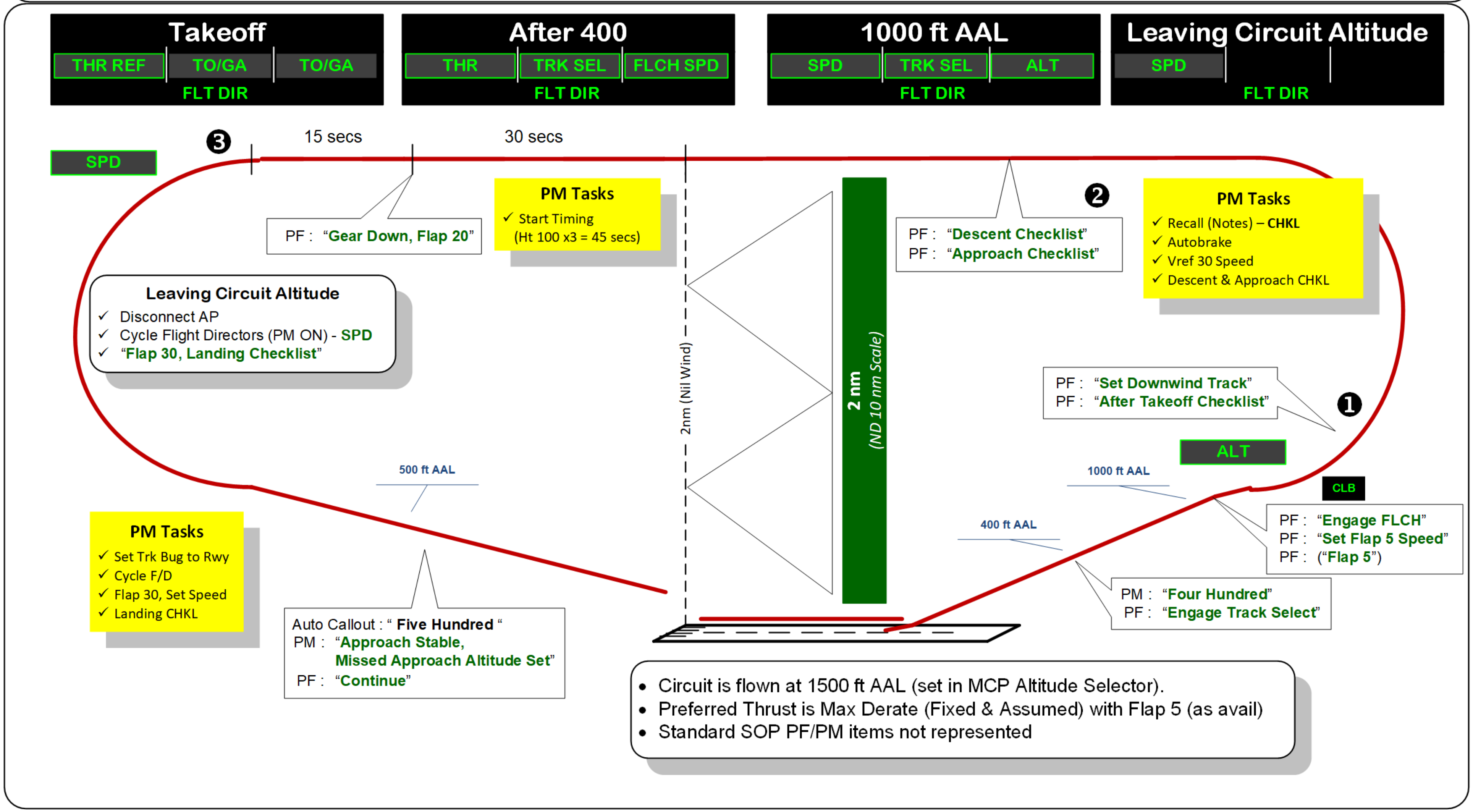
Flight Director On Circuit Pattern Notes

- Circuits are flown at 1500 ft AAL. Circuit timing commences abeam the threshold downwind and is a function of the height above the airfield in hundreds of feet – times 3. Thus 1500 ft AAL = 45 seconds timing. This pattern keeps procedural consistency with circling approach procedures to ensure adequate spacing and contains the aircraft within the circling area.
- Takeoff should utilise max (fixed & assumed) de-rated thrust.
- Flap 5 takeoff should be encouraged; higher flap settings can be used as required, in which case at 1000 ft AAL an additional call for "**Flap 5**" is made at **ALT** capture when the aircraft accelerates.
- An active route with an active runway is required for V Speeds; a SID/Departure is not required.
- Note that if the selected speed is changed prior to **ALT** capture, the speed will not "jump" up to commence acceleration - instead Flap 5 speed will remain as set. Alternatively the use of FLCH at 1000 ft AAL (to set CLB thrust) also prevents the speed accelerating at **ALT** capture.
- FMC lateral/vertical changes should be minimised. Circuits are a Visual/Scan training manoeuvre – FMC changes should be limited to setting the VREF30 speed and if required, selecting the landing runway extended centreline.
- For the purposes of training only –see **CDU VNAV DESC Waypoint/Alt – FPA/Bearing/VS information**.
- 2nm spacing is ideal in nil wind - the base of the aircraft symbol (△) on the ND is 1nm when the scale is set to 10nm.
- PM should "keep things moving" on downwind (*Setup, Recall, Notes, Checklists, etc*) – especially during the early circuits.
- When leaving circuit altitude, AP must be disconnected, and Flight Directors "cycled" (see **Flt Director OFF at Minima?**)
- A useful tip for the PM is to increase ND scale to 20nm for the base/final turn to give a longer ND turn prediction display, facilitating more accurate turns onto final in crosswinds. Remember to overshoot or undershoot the final runway track into the crosswind.

Circuit Pattern - Wind Corrections

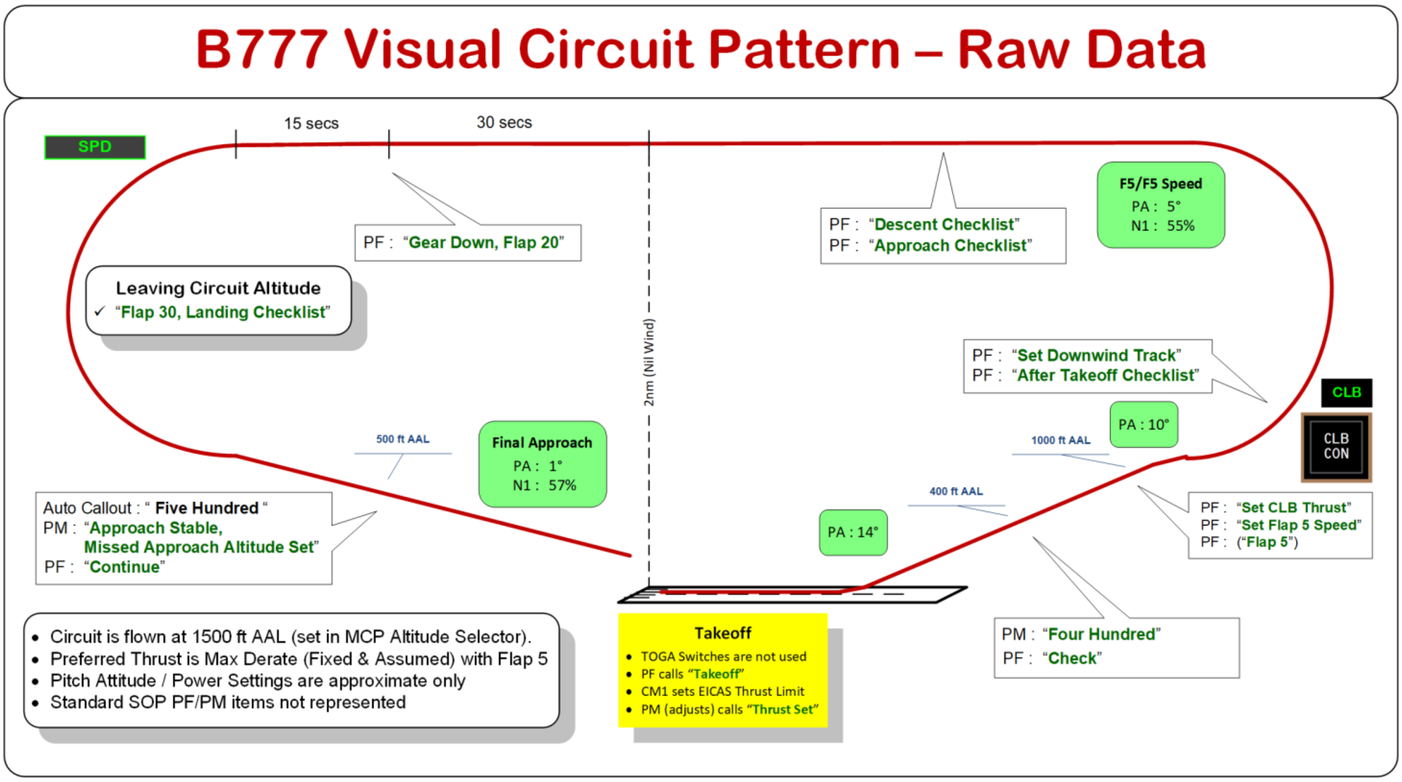
❶ Angle of bank on the initial turn can be changed (shallower into wind) - 15° AoB typically widens the circuit for crosswind.
❷ An offset into wind on downwind track can increase lateral offset to allow for wind on base.
❸ Calling for "**Flap 30, Landing Checklist**" at 45 seconds results in a tighter turn onto final approach; timing can be adjusted for into wind (*typically no correction is made for tailwind when downwind*).

B777 Visual Circuit Pattern – Flight Director



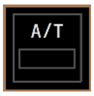
10.10. Circuit Pattern – Raw Data

Visual Circuits can be flown using Raw Data (*no Flight Director*) and manual thrust. This activity rapidly returns scan rate and hand flying skills, as well as reminding crew that the Thrust Levers don't always take care of themselves …



Raw Data Circuit Pattern Notes

- Basic Circuit Pattern (*including allowance for crosswind*) is as per **Circuit Pattern – Flight Directors ON**.
- Raw Data Circuits can be flown with Auto Throttle active. This can be achieved by using the TOGA Switches as normal during takeoff – then cycling the Flight Directors after **ALT** capture; or by selecting the A/T Switch to activate the auto throttle. In either case ensure the FMA reflects the auto throttle engaged in **SPD** mode.



- A manual thrust takeoff is actioned by the PF calling "**Takeoff**" as usual after line up. The Captain advances the thrust levers to 50% and after checking engine stability – advances the thrust towards the EICAS indicated Takeoff Thrust setting. The PM will call "**Thrust Set**" as usual. The Captain as PF should still be able to set takeoff thrust; as long as an approximately equal (*or higher*) thrust setting is achieved this is adequate. To engage the A/Thr after takeoff, use the MCP A/T push button.
- At 1000 ft AAL, Climb Thrust can be called for by the PF and set by the PM using the CLB/CON Autothrottle switch.
- Pitch attitudes and power settings are approximate only for mid weight range. FPV can be used for level flight.

- Remember that the fly by wire system in the 777 requires trimming for airspeed changes only. Once trimmed – very little control input is required (*vertical or lateral*) to achieve steady state flight. Most of the directional control issues are pilot induced …

11. Pre-Flight

11.1. Pre-Flight Briefing – Management

The complexity and volume of the pre-flight paperwork of a long-haul international flight, coupled with the time pressure that is typical of the pre-flight regime, must be managed effectively by the flight crew.

Captains new to augmented operations must also learn to manage the effective and efficient use of the relief crew during pre-flight. Use of relief crew outside of in-flight relief duties should be done in a manner that decreases the workload on the operating crew without introducing opportunities for error, nor reducing the situational awareness of the Operating Crew – irrespective of the rank of the relief crew available.

Captains are encouraged to allow the First Officer to run the pre-flight briefing when the First Officer is PF.

Crew/Task Management

Captains can utilise the available relief crew to divide the tasks required during pre-flight briefing in order to expedite and improve the process. As long as the crew present are qualified, there are no limitations associated with splitting into pairs or singles for review of Weather/NOTAMs/FCONs and other flight documents.

However, a summary of the pertinent information must be reviewed by the crew as a whole once each crew member has completed their task.

It's important for Captains to realise that when Briefing components are delegated – the **task** is being delegated but not the **responsibility**.

Captains must ensure that as the result of the pre-flight documentation review they have a sufficiently detailed knowledge of the CFP, Weather and NOTAMS to be able to certify as to the legality of flight dispatch and make informed decisions on aspects such as the fuel load, choice of alternates, etc.

Likewise, relief crew must appreciate that when reviewing NOTAMS/Weather for the operating crew, this task is unlikely to be re-checked prior to dispatch and as such the operational responsibility implied is significant. Relief crew who are delegated the task of reviewing NOTAMS and Weather are **not** being asked to ensure the legality of dispatch – they are being tasked with gathering information relevant to the flight necessary to inform and therefore enable the Captain to assess the legalities of the flight, as well as other aspects such as the fuel load.

Typically, the NOTAMS and Weather are delegated to different crew members or groups, despite the need to analyse both of these information sets against each other simultaneously to gain a full overview when making dispatch related decisions. Thus, the individual crew reviewing these segments of the information must allow for the possibilities of the other when summarising the results.

For example ...

- If destination Melbourne Runway 27 is closed by NOTAM for the arrival, this might not seem crucial because RW16/34 remains available and is the primary runway of use in any case – but if the wind was a strong westerly near the crosswind limit of the aircraft and the crossing runway closed - extra fuel might well be a consideration. In any event – closure of a useable runway at an operational airport should be a must know for the Captain, irrespective of other runways that are available.
- If the VOR at the Alternate Avalon was unserviceable, this might not be considered relevant to dispatch because the Avalon ILS would be the primary approach aid in any case. But if the wind in Melbourne is a northerly, this coupled with a lack of RNAV and Circling Approach approval - suddenly Avalon looks like a poor choice as an alternate. Particularly if thrown into the mix is a re-clearance flight plan resulting in minimum contingency fuel. Ask me how I know this …

CA / PF : Task Delegation

This procedure is a suggested technique only. CA/PF may delegate pre-flight briefing tasks according to requirements / preference.

PF : OFP Review

Review OFP as a group. Highlight Important / Unusual / Limiting factors and items relevant for Weather/ NOTAM Review.

- Limiting Weights (TOW/ZFW/LDW/Fuel)
- Dispatcher Notes (Re-Dispatch/ERA/Etc)
- EDTO Airports / Times / Critical Fuel ETP's
- Unusual Cost Index / Perf Degr
- Block/Flight Time Margin
- Alternates / ALTN Holding

PF & RCM1 : Weather/FCON

TAF/METARs for required airfields. SIGWX Charts and identify relevant NTC's.

- **TAF/TTF METAR** : Departure, Takeoff Alternate
- **TAF** : EDTO's, Destination, Dest Alternate(s)
- **SIGWX** Chart (Jet, CAT, Volcano, Cloud, Icing, etc)
- **NTC**'s : Relevant for Flight
- OFP **INTAMS**

PM & RCM2 : NOTAMs

Review together relevant Airfield NOTAMS as well as FIR NOTAMS for the first hour of flight.

- **NOTAMS** : Departure, Takeoff Alternate, EDTO, Dest Alternate(s)
- **FIR** : First Hour of Flight

PF : Flight Overview

PF leads a combined overview of Weather, NOTAMS and other related flight documentation items.

- Departure Airfield, Takeoff Alternate
- Destination Airfield
- EDTO Airports
- Destination Alternate(s)
- FIR NOTAMs (First Hour)
- SIGWX Chart, NTC's, INTAMS
- Determination of Fuel Load
- Summary of critical aspects of Flight

11.2. Pre-Flight Briefing – Expediting

Often there is limited time before departure for a complete review of the flight briefing package on long haul and particularly ultra-long-haul flights. Even with an augmented crew (*sometimes especially with an augmented crew*) time is tight and this process needs to be reduced to the minimum necessary for legal departure. Typically, this means:

- Weather and NOTAMS for Departure (*including Takeoff Alternate if required*), Destination, Destination Alternate(s) and EDTO Alternates.
- Area & FIR NOTAMS for Departure, Destination and First Flight Hour.

When time is tight, these are the minimum items required to ensure legal dispatch of the aircraft.

Weather Forecast Review

Reviewing airfield weather can be expedited by having in mind a set of wind, cloud and visibility criteria used to avoid a detailed assessment of a forecast. If the forecast does not involve Wind of more than 30 knots; significant cloud below 1000 ft; visibility below 5km/3sm then the forecast does not need to be read in detail. These values allow for dispatch with an EDTO airfield that has one runway and a non-precision approach. This should cover all cases other than perhaps a one-way runway with a strong tailwind component.

If a first glance at the weather forecast reveals phenomena below these minima's then a quick look at the validity period, or presence of a leading TEMPO or INTER often allows the rest of the forecast to be skipped. Other than the alternate; destination and final ETP EDTO Alternates – ULH flights generally have lots of fuel to hold through enroute INTER/TEMPO, etc.

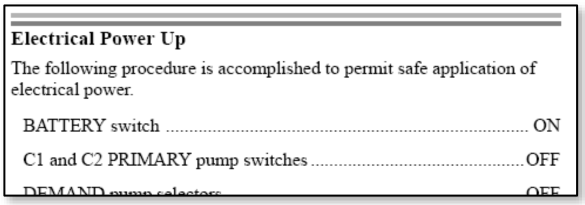
NOTAM Review

Similarly, speed reading NOTAMS is typically not a process of looking for applicable NOTAMS, but rather a process of quickly eliminating non-applicable ones. NOTAMS that can quickly be eliminated include:

- NOTAMS outside the validity period of your flight/flight segment;
- NOTAMS that concern Runways/Approaches/Procedures the Airline/Fleet/Crew isn't authorised for, or won't need;
- NOTAMS that don't directly affect dispatch legality – such as taxi ways; parking stands; STARS at departure; SIDS at enroute, destination and alternate airports; Airport works that don't directly affect Runway lengths; etc.

Assuming the minimum pre-flight briefing, NOTAMS need to be reviewed in detail shortly after top of climb as the enroute and destination and destination alternate airfields come into range – prior to this only the legalities of the operation need to be considered when time is short.

11.3. Aircraft Power Up


Electrical Power Up

The following procedure is accomplished to permit safe application of electrical power.

BATTERY switch .... ON

C1 and C2 PRIMARY pump switches .... OFF

DEMAND pump selectors .... OFF

Aircraft power up is a seldom used procedure. Rather than actioning from memory, or by some form of off the cuff pre-flight scan – this process should be done using the specific Supplementary Procedure in the Boeing FCOM.

If you arrive the aircraft after a power down and it's clear the power up procedure was not done correctly (*eg: Battery Switch still OFF*) – speak to the engineer and/or verify the rest of the Electrical Power Up procedure.

11.4. Starting the APU – Start, Release to ON

The 777 APU Start Switch has a known history for releasing back to the OFF position after it is started in a fairly casual manner by crew. The technique is to position the switch from OFF through ON to START, Pause, then Release to ON – ensuring the inbuilt spring does not allow the switch to flick through to OFF.

11.5. TFC on the ND during pre-flight

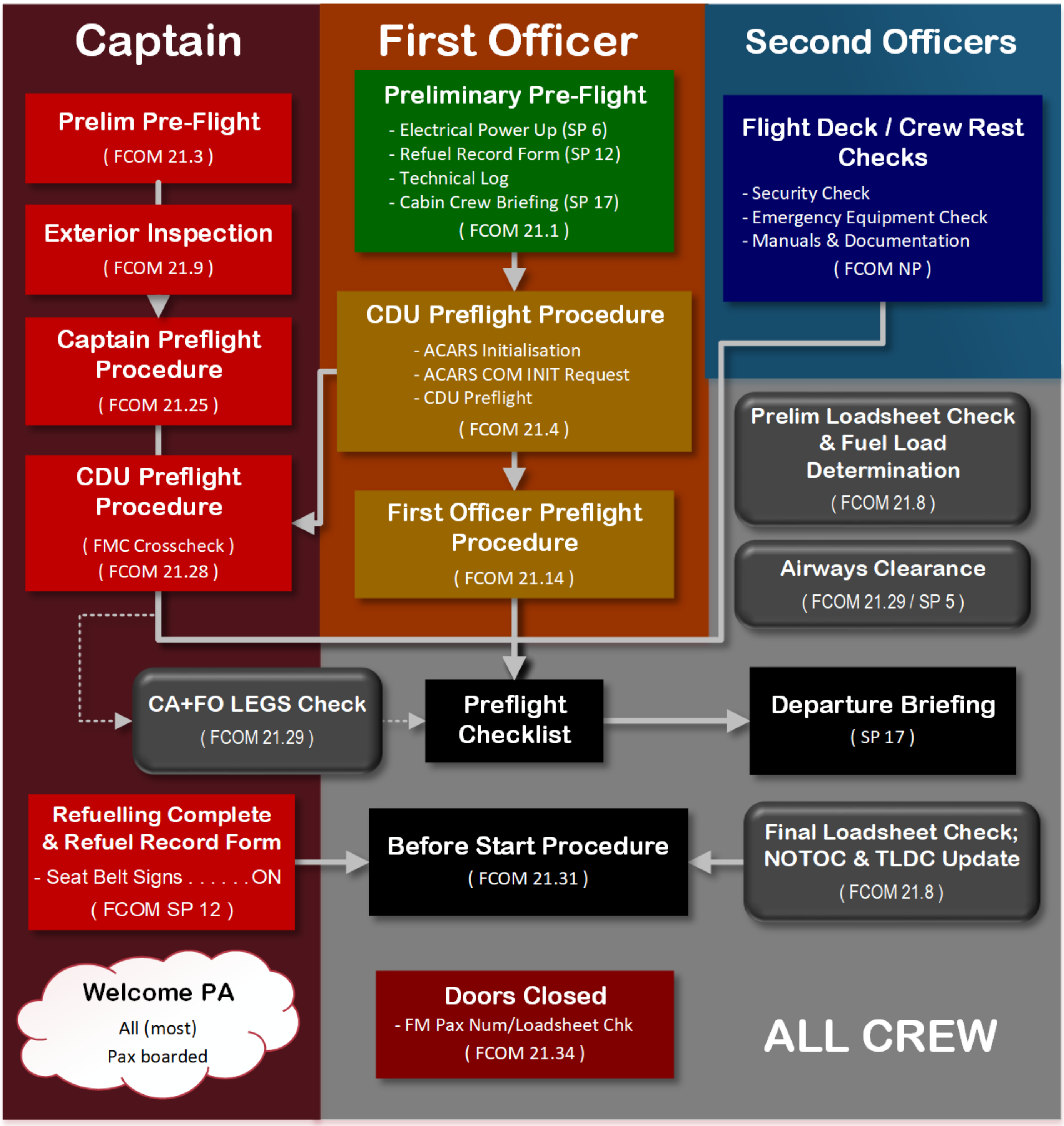
It is easy to miss the fact that TFC (*or TCAS OFF*) is not displayed on the ND during pre-flight. Crews have been observed to complete a simulator session without any TFC display right up until the point where a TCAS RA activation during descent brings the TFC popup for both pilots.

There are several techniques employed by crews to trap this human factors weakness in the aircraft. Some involve a pre-thought out scan of the ND during pre-flight - working left to down to Right – ARPT, WXR/TERR, TFC, VOR-L, GPS, VOR-R, then DATA, POS.

The TFC selection is probably best trapped by the First Officer during the Before Start Flow. As a general airmanship principle **switches and controls in the aircraft should not be actioned without verification**. Based on this principle, when the First Officer selects 'TCAS RA' on the centre console during the after-start flow, the First Officer should look up at both ND's to ensure that TFC has replaced the TCAS OFF annunciation

11.6. Pre-Flight Flight Deck Task Sequencing

The Standard Operating Procedures assigns tasks to various operational crew members for the pre-flight stage. The following diagram attempts to encapsulate the essence of the Captain/2/3/4 pre-flight activities.



- Pre-flight is a fluid environment where crew are expected to react appropriately and efficiently to a number of changing variables and inflexible constants. Some procedures can be actioned out of scripted sequence (*such as PDC Request, Briefing*); but most action items are dependent on the completion of previous pre-flight requirements (*such FMC Data Entry requires Refuelling Completion*). The arrows attempt to identify these dependencies – not all dependencies are shown.
- Typically, the Captain deals with all Pilot to Ground Engineer comms; the First Officer handles all VHF coms. This doesn't preclude tactical changes that suit the operation as long as the crew are clearly communicating who has what, nor does it preclude the PRCM from using the centre RTP to assist Primary Crew (*ATIS, Company, etc*).
- Departure Briefing should be conducted after initial FMC entries and cross checks. If the Airways Clearance is not available, the Briefing can be completed based on planned/expected clearance and updated as required.

- Items such as Final Fuel Determination, Briefings, Airways Clearance and FMC Performance Entry are expected to be conducted with all crew present to aid in error detection and raise/maintain situational awareness.
- The Preliminary Pre-Flight Loadsheet is often requested early in the pre-flight. When it arrives, the Captain will review this (*ideally*) with the crew to determine a final fuel load determination.
- The FMC LEGS check is only required when non-database custom waypoints (*such as UPR Latitude/Longitudes*) are utilised and is separate to the Route Check and cross check action by the First Officer/Captain. Note the LEGS check is scripted here before the Pre-Flight Checklist but this is for convenience only and is often left until later in the pre-flight.
- The Refuel Record form is completed by the PM (PRCM) and checked/signed by the Captain. This form is still required when no refuelling takes place.
- All crew are expected to be present on the flight deck for the Pre-Flight Checklist; Departure Briefing; Final FMC Performance Entry Procedure and when the Flight Deck Door is locked for Departure. Ideally all crew should be present and involved (checking) when the Preliminary Loadsheet Fuel Load Determination and the Final Loadsheet actioned/checked as well as the determination of Takeoff Performance Data.

11.7. Pre-Flight Checklist – Altimeters

PREFLIGHT CHECKLIST	
Oxygen .... Tested, 100%	ALL
Flight Instruments......Heading ___ Altimeter ___	BOTH
Parking brake ....Set	C
Fuel control switches ....CUTOFF	C

The Altimeters check in the Pre-Flight Checklist is a cross check of the barometric subscale setting – not the altitude reading itself. Thus, the proper response to the blank line on this checklist is the current subscale setting, not the indicated altitude.

The ADIRU takes air data from three sets of balanced sources and produces a single output to both PFD's – as such there should never be a difference in altimeter readout (*assuming the correct subscale is set*) between the two PFD's, unless a system failure is present (NAV AIR DATA SYS) or an Air Data/Attitude Source Select switch has been selected.

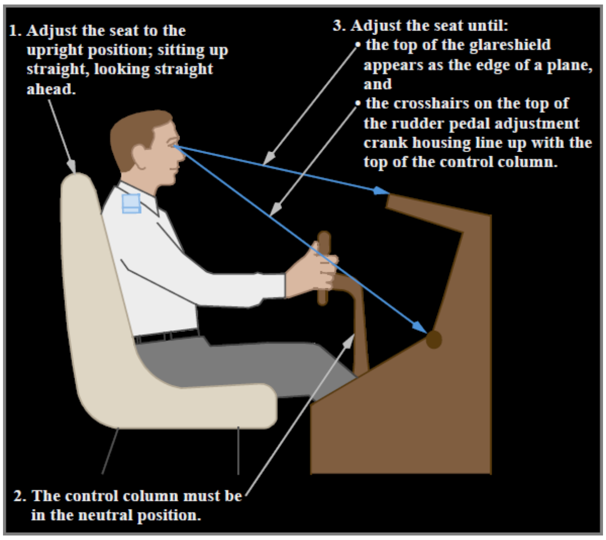
Note that the Integrated Standby Flight Display sources air data and attitude information from its own independent sources, not the ADIRU/SAARU systems.

11.8. Seating – Eye Position

It is common for crew to have poor seating position in the aircraft. Boeing provides very specific guidelines on correct seating position in the FCOM – crew should be familiar with the procedure.

Typically, this seating position maximises the pilot's view over the glare shield while maintaining good eye line with the instrument panel. The seating position proscribed is most crucial at the minima in poor visual conditions where clear sight of the approach lights can determine the outcome of the approach, as well as in the landing flare where a poor seating position can mean the pilot has to stretch upwards to see the end of the runway in the last moments of the landing.

Once in the proscribed position, if you feel like you're sitting with your head on the roof and your nose on the window and you're not in any way comfortable – you probably have it right.

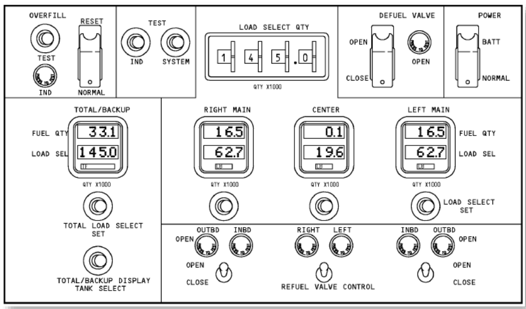


11.9. Defuelling

If you are ever required to de-fuel the aircraft, best of luck to you.

- Typically, defueling pressure may well only be provided by the aircraft pumps only. As such the rate is approximately 80kg/min (and that includes APU usage).
- Countries with extensive domestic operations (*such as Australia*) have local regulations that do not permit the mixing of international and domestic fuel. This means the availability of a "sucking" defueling truck may be limited.
- Flight Ops Manuals, A1, Maintenance Procedures Manuals and Local Regulations should be carefully consulted because defueling with passengers onboard can be prohibited by some authorities.

11.10. Revising the Standby Fuel Figure (NOT)

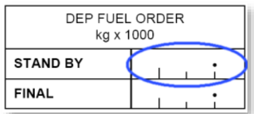


Before pre-flight the Airport Movement Co-Ordinator (AMCO) provides the airport refuelling personnel a Standby Fuel Figure (*5 tons below CFP Fuel Required*) to which the aircraft is to be initially fuelled.

When providing the Refuel Record Form to engineering/refueller – Flight Crew should avoid providing a Standby Fuel figure different to this, unless a lower one is required because of early notification of a *significant* ZFW drop. This will allow for a gross error check of the standby fuel figure and reduce refueller workload as detailed below.

Refuelling personnel will arrive at the aircraft, prepare the refuelling equipment, connect to the aircraft and establish a refuelling configuration based on the AMCO nominated 5 ton below figure. This figure is established through the integrated refuelling panel in the left wing, which has to be accessed through a lifting platform.

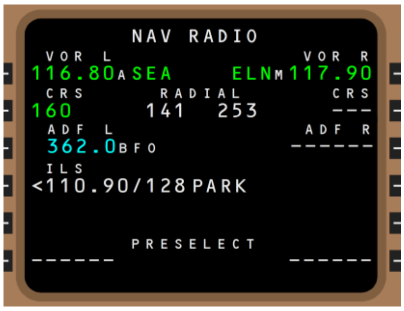
If the pilots then subsequently provides a revised figure, the refueller has to re-visit the refuelling panel, often to adjust the intended 5 ton below figure by a few hundred Kg. Unless final ramp fuel is going to be less than the AMCO nominated figure – this revision to the Standby figure is un-necessary, resulting in an increase in workload and another opportunity for error in the refuelling of the aircraft.



Essentially : The Standby Figure provided on the Refuel Record Form should only differ from the 5 ton below CFP figure provided by Ops when this figure is likely to be more than Final Ramp Fuel.

Since this usually means a drop in Ramp Fuel in excess of 5 tons (*reduction in ZFW of over 10 tons*) it shouldn't happen very often.

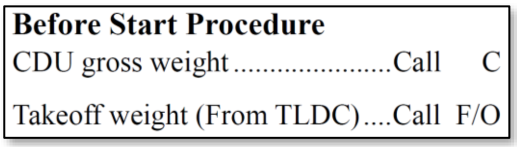
11.11. ILS Tuning for Departure



During LVOPS, crew have the option of tuning the runway ILS to provide a positive confirmation of the correct runway on line up in poor visibility. However the Localizer is not an authorised source for runway tracking guidance during the takeoff roll. It's also worthy to note that the Localizer becomes more sensitive as the aircraft proceeds down the runway.

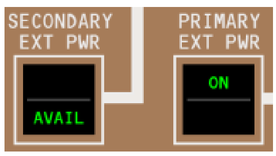
If there is no ILS for the runway of departure, it is possible to tune the reciprocal ILS for the opposite direction. In this situation the normal course QDM should be entered (*as depicted on the approach chart*) – the ILS received will still provide a correct sense centreline indication on line up. Specifically – if departing off RW16, the RW34 ILS can be tuned with a course of 340 (*assuming that is correct for RW34*) – which will provide correct centreline confirmation/deviation.

11.12. Is 'Check' a valid Crosscheck



The Final FMC Takeoff Performance Data Entry Procedure generally requires the First Officer to ***Call*** relevant values from the TLDC – rather than just announce "**Check**" for correct values. By calling an actual value crosscheck from the TLDC solution, this allows the Captain to perform a more valid cross check of the selections and values in the FMC.

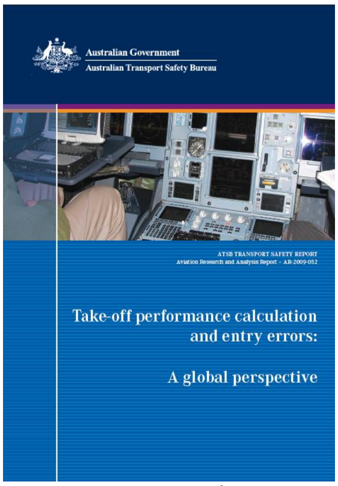
11.13. Cleared to disconnect external power Captain?



Engineering should not disconnect ground power without first confirming with the flight deck crew.

When asked by the ground engineer for clearance to disconnect the external power – ensure that external power has been deselected on the overhead panel before clearing the ground engineer to do so. Disconnecting ground power while it's still connected to the Bus can leave the aircraft with significant electrical system abnormalities. Ask us how we know this ...

11.14. Takeoff Performance – Lessons from the Industry



In January 2011 the Australian ATSB released a Safety Report into Takeoff performance calculation and entry errors. This report details 31 accidents & incidents from Australia and internationally that involved takeoff performance calculation/entry errors along with the analysis and benefits of hindsight from these occurrences.

Change and Distraction

One of the major threats applicable to our operation identified in this report is ***Change in Conditions.*** Whether a runway change, aircraft weight change, or some other requirement forcing a re-calculation and re-entering of performance data – having followed a robust set of SOPs to achieve an accurate takeoff calculation, crew procedures must not be allowed to break down subsequently into a casual update of the "changed" information. The takeoff data re-calculation must be subject to the stringent SOP crosscheck and data entry procedural flow of the first solution.

While we are at least as subject to change as any other airline, we are also clearly subject to **Distraction** during the pre-flight phase. The words included in this section of the ATSB report include **Task Experience**/**Recency**, **Time Pressure**, **Distractions**, **Incorrect Task Information**, **High Workload**, **Task Completion Pressure**, **Preoccupation**, and **Fatigue** – all should be familiar to the pilots of any ULH flight operation.

TLDC (Takeoff Landing Data Calculation) Request Solution Check

```
*** B777 TAKEOFF DATA ***
AIRCRAFT   VH-VPD/
AIRPORT    KLAX / LOS ANGELES
RWY/INTX   25R/FULL    TORA 3685
SPECIAL    -
RWY COND   DRY
WIND       250/05  HW 5
OAT/QNH    35C / 1013 HPA
FLAPS/CG   TLDC / FWD            CHK BY
THRUST     TO
PLAN TOW   330.5        --------------
PACKS/AI   AUTO / AUTO
MEL 1/2    NIL/NIL
MEL/CDL    NIL
--------------------------------------
PLN TOW 330.5    A/T LIMIT 333476 KG
--------------------------------------
TO    40C  101.0%
                            V1 171
EO ACC 1000 FT AFE
                            VR 174
FLAPS 15    CG FWD
                            V2 179
RWY/INTX    SPCL
25R/FULL    -            VREF30 176
--------------------------------------
SEFP: TRK 249.
AIT: TRK 249 CLB MSA. NADP: STD.
--------------------------------------
ERROR: NIL
-- END --
```

The TLDC request can be generated by either pilot (*or both*) based on either flight plan or Loadsheet data and the anticipated ambient conditions. While the cross check of the **request** is not a mandatory requirement – the cross check of the TLDC **solution** is. **This includes verification of the request (*top*) portion of the result, as well as the solution (*lower*) section.** Ensure the performance data you're about to use is valid against the conditions that will exist for takeoff – rather than the conditions that existed when the original request was made.

- The request should be valid in terms of the Airport, Runway, TORA, etc., and anticipated ambient conditions – usually a combination of the current ATIS and the benefit of operational experience.
- The thrust selection in the solution (TO/TO1/TO2) must match that of the request section.

Before Start Procedure - Final FMC Performance Entry

The SOPs are designed around two crew working together to enter and crosscheck critical takeoff performance entries. This includes observation/cross check by relief crew.

11.15. Pre-Flight Oxygen Mask Test / Oxygen Check

When conducting an Oxygen Mask check – there is a requirement to verify crew oxygen pressure after the check. This requirement exists for all four masks on the flight deck. **Put another way – all oxygen masks should be checked prior to verifying crew (*and passenger*) oxygen pressure/quantity for flight.** The First Officer mask must be checked last as it is considered to be the weakest link in the system.

Additionally, there is a regulatory requirement to verify the serviceability of an oxygen mask microphone prior to flight. This can be done by selecting the intercom on (to either speaker or headphones) during the mask test (*Emergency/Test Selector … Push and Hold*). The sound of oxygen flowing should be clearly heard over the speaker/headphones, verifying the oxygen mask microphone.

Oxygen .... Test and set

Oxygen mask – Stowed and doors closed

RESET/TEST switch – Push and hold

Verify that the yellow cross shows momentarily in the flow indicator.

EMERGENCY/TEST selector – Push and hold

Continue to hold the RESET/TEST switch down and push the EMERGENCY/TEST selector. Verify that the yellow cross shows continuously in the flow indicator.

RESET/TEST switch and EMERGENCY/TEST selector – Release

Verify the yellow cross does not show in the flow indicator.

Normal/100% selector – 100%

Crew and passenger oxygen pressure – Check EICAS

Verify that the pressure is sufficient for dispatch.

11.16. Entering Performance Information into the FMC

Takeoff performance entry typically requires a final Loadsheet and TLDC with refuelling complete. The data is inserted by the Captain as called by the First Officer as part of the Before Start Procedure.

A key concept is the challenge/response nature of the data being provided by one pilot and checked/entered by another. For example, when the Captain calls out the CDU VREF30 speed – the correct response is for the First Officer to call the VREF30 from the TLDC – responding "**Check**" is insufficient.

It is the First Officer's task not just to call the data or observe the Captain entering values from the Loadsheet into the FMC – but to check and verify the accuracy of the entries called/made.

The following script is an example only.

CA :	*"Loadsheet Zero Fuel Weight is 215.0"* *"CDU and Totalizer Fuel is 120.0, OFP Required Fuel is 120.0"* *"CDU Gross Weight is 335.0 – What do we have on TLDC?"*
FO :	*"TLDC Planned Weight 334.2"*
CA :	*"Ok, that's 800 kg taxi fuel, checked. "* *"Thrust Setting?"*
FO :	*"TLDC has TO2 with 35 degrees."*
CA :	*"TO2 selected, 35 degrees set. EICAS has D-TO2 35, N1 of 89.5, CDU 89.4 and Climb 1 is Armed."*
FO :	*"TLDC N1 is 89.8"*
CA :	*"Engine Out Acceleration?"*
FO :	*"TLDC has 1000 ft"*
CA :	*"1000 checked. Acceleration is 3000, Climb 1 at 1000, Noise Abatement."*
CA :	*"Flap?"*
FO :	*"Flap 5"*
CA :	*"MACTOW is 28%, Runway is 25L full length – what do we have on TLDC?"*
FO :	*"TLDC is Runway 25L full length."*
CA :	*"Speeds?"*
FO :	*"V1 170, VR 178, V2 185"* (done in turn)
CA :	*"V1 170, Vr 178, V2 185"*
CA :	*"VREF30 169 kts"*
FO :	*"TLDC VREF30 168 kts"*
CA :	*"1 knot lower in TLDC for taxi fuel is ok – Loadsheet VREF30 checks. V2 is 185, set on MCP. LNAV/VNAV Armed, Initial Heading 250 set, Clearance Altitude 3000."* [Checks PFD]
CA :	*"Climbing to 310, Optimum 315, Maximum 328, Recommending 310. Fuel at Destination is 11.0, which agrees with the Flight Plan."*

Before Start Performance Entry Procedure

INIT REF **PERF INIT** Page	**Push**	CM1
Zero Fuel Weight (ZFW) *Enter the Zero Fuel Weight from the load sheet into the CDU.*	**Enter**	CM1
Fuel Quantities (FUEL) *Verify Fuel on the CDU, OFP and EICAS Totalizer Fuel are in agreement.*	**Check**	CM1
CDU Gross Weight (GR WT)	**Call**	CM1
TLDC Plan Takeoff Weight (PLN TOW) *Compare CDU Gross Weight and TLDC Planned Takeoff Weight* *Allow for Taxi fuel between these two figures.*	**Call**	CM2
THRUST LIM > line select key	**Push**	CM1
Fixed Thrust De-Rate and Selected Temperature *CM2 will call the Thrust De-Rate and/or Selected Temperature or TOGA thrust from TLDC and check the CM1 entry.*	**Call**	CM2
Fixed Thrust De-Rate/ Selected Temperature *Select Thrust De-Rate and/or enter Selected Temperature or verify TOGA takeoff thrust. CM1 should verify EICAS de-rate/temperature selections and Target N1 setting. Note that the TLDC/CDU/EICAS N1 can vary slightly.*	**Enter/Verify**	CM1
Armed Climb Thrust Setting *CM1 calls the armed Climb Thrust setting for later situational awareness.*	**Call**	CM1
TAKEOFF > line select key, **NEXT PAGE >** *(TAKEOFF REF P2)*	**Push**	CM1
TLDC EO ACC *(Engine Out Acceleration Height)*	**Call**	CM2
CDU EO ACCEL HT	**Verify/Enter**	CM1
CDU ACCEL HT / THR REDUCTION	**Verify/Enter**	CM1
PREV PAGE > line select key *(TAKEOFF REF P1)*	**Push**	CM1
TLDC Takeoff Flap Setting	**Call**	CM2
CDU FLAPS	**Enter**	CM1
Takeoff CG (MACTOW from load sheet)	**Enter**	CM1
CDU Runway / Intersection (RUNWAY/POS)	**Call/Enter**	CM1
TLDC Runway / Intersection	**Call**	CM2
Takeoff Speeds (TLDC V1, VR, V2)	**Call**	CM2
Takeoff Speeds (CDU V1, VR, V2)	**Enter**	CM1
INDEX > line select key, **APPROACH >** line select key	**Push**	CM1
CDU Flaps 30 VREF Speed	**Call**	CM1
TLDC VREF 30 Speed	**Call**	CM2
Loadsheet Acceptance VREF 30 Speed *CM1 check CDU VREF 30 speed (-0/+1 knot) with the TLDC/Loadsheet Acceptance*	**Verify**	CM1
INIT REF key *(TAKEOFF REF)*	**Push**	CM1
MCP V2 Speed	**Set**	CM1
LNAV push button	**Arm as needed**	CM1
VNAV push button	**Arm as needed**	CM1
Initial Heading/Track	**Set**	CM1
Initial Altitude	**Set**	CM1
VNAV > key, **NEXT PAGE >** line select key *(VNAV CRZ page)*	**Push**	CM1
CRZ ALT vs OPT/MAX/RECMD Altitudes	**Check**	CM1
Fuel at Destination *CM1 should compare OFP/FMC fuel at destination for reasonableness.*	**Check**	**CM1**
INIT REF key *(TAKEOFF REF)*	**Push**	CM1

11.17. FMC Performance Entry – Role Reversal

There is **good research** to suggest that generally speaking, Captains make less mistakes than First Officers. Don't shoot the messenger! There is also good research to contend that generally – Captains do a much better job of correcting First Officers than the other way around (*anyone surprised about that?*). Finally – research also suggests that when designing critical procedures – such as Takeoff Performance data entry and cross check/verification – the more fault tolerant paradigm is for the First Officer to make the actual entries of data – and the Captain to provide the cross check. If you think about it – this is the underlying paradigm of Boeing NP SOPs during pre-flight, where the First Officer works madly during pre-flight to do basically all the work – and the Captain cross checks and corrects that work.

The aforementioned procedure described in **Entering Performance Information into the FMC** does not confirm to this paradigm – how does your airline do it?

11.18. Uplinked Winds – First Level Missing

The FMC LEGS RTE DATA pages can store winds at up to four levels for the flight. When the flight is planned at more than 4 enroute levels (such as F280, F300, F320, F340, F360) then someone is going to lose out. Typically, in this situation the FMC ignores the first level, instead choosing to uplink forecast winds for F300 through F360, leaving F280 with no winds at all.

There's a kind of a logic to this selection. If the winds are not uplinked for the last planned level, this typically has a significantly detrimental effect on the fuel/time prediction. Usually by leaving out the initial level, the estimate for time/fuel at destination is still pretty accurate, even at pre-flight.

Unfortunately, this ignores the shorter-term tactical needs of the flight. During departure climb, the FMC's calculations around the suitability of F280 can be radically affected by the lack of forecast wind opposed to the wind uplinked at F300. Either the FMC will recommend bypassing F280 for F300 (*where there is a tailwind*) or the FMC will recommend levelling at F280 and may not recommend any climb to F300 for a very, very long time (*to avoid the headwind at F300*).

The best tactical solution is usually to delete the F340 level winds (*one level below the highest level*) and insert F280 into a LEGS RTE DATA WINDS page, then request updated winds. With the F280 winds the FMC will be better able to recommend for/against level changes in the first few hours of flight. Meanwhile the FMC will wash the FL360 winds down when calculating flight at FL340. Once you've reached F300, you can re-request winds for F300 through F360 for the rest of the flight.

11.19. FMC Reserve Figure

The FMC Reserves figure is based on the minimum figure required at the destination airport to reach the Alternate in the event of a diversion. This includes CFP Alternate Trip, CFP Alternate Holding and CFP Final Reserve (30 mins) Fuel.

The purpose of this value in the FMC is twofold:

FMC DATA ENTRY		TIME	FUEL
RES 8108	TRIP	14:08	119976
	CONT	00:14	2000
	DEST TFC	00:00	0
	DEST WX	00:00	0
	ALTN YSCB	00:36	5074
	ALTN WX/TFC	00:00	0
	FXD RES	00:30	3034
	ETP B/U	00:00	0
	RCL B/U	00:00	0
	MIN REQD	15:28	130084

- The FMC scratchpad message "**INSUFFICIENT FUEL**" is generated when the predicted fuel on board at Route Destination is equal to or less than the RESERVES value.
- The **HOLD AVAIL** time calculation on the FMC Hold Page is based on arriving at Destination with at least RESERVES intact.

It should be noted that while the SOP is to insert the minimum figure into the FMC RESERVES field during pre-flight, re-considering this value during the pre-descent setup is often worthwhile. Typically, most pilots prefer for the FMC to advise them slightly (*1 ton or so?*) prior to that point at which the flight is unable to continue to destination with CFP alternate diversion fuel intact, rather than just after an unintended commitment to destination.

In the event of a diversion from planned Destination, this figure will need to be altered. While typically the CFP 30 minute reserve fuel figure is used, entering a value of at least 4.2 tons should warn the crew in advance of an impending requirement to run the ❑ **FUEL LOW** Checklist.

11.20. DDG vs MEL vs CDL

The CDL (*Configuration Deviation List*) is contained with the DDG (*Defect Deviations Guide*) along with the MEL (*Minimum Equipment Listing*) and uses the same ATA Chapter basis to reference defects. These chapters are based on industry accepted definitions of aircraft systems such as ATA 21 – Air Conditioning; ATA 32 – Landing Gear; etc.

While the line can be blurry, the MEL typically refers to airworthiness items that are unserviceable on the aircraft; the CDL typically refers to bits that have fallen off the airframe.

777 Dispatch Deviations Guide

Section 2	ATA 21
Table of Contents	**Air Conditioning**
Positive Pressure Relief Valves	**2.21-32-01.1**
Option A: One Valve Inoperative	2.21-32-01.1
Option B: Both Valves Inoperative	2.21-32-01.2
Section 3	**ATA 21**
Table of Contents	**Air Conditioning**
Negative Pressure Relief Vent	**3.21-32-01.1**
ECS Ram Air Exhaust Louver	**3.21-52-01.1**

Since both documents are contained in the same manual; since they use a common referral system – there is a potential for confusion when referring to the deferred defect record in the tech log on an existing defect. Occasionally engineering don't refer to a specific MEL vs CDL (Ch2 vs Ch3) section when recording deferred defects. It's simple when you can't find a recorded defect in the Ch2 MEL section – have a look in the CDL.

However, when dealing with a defect that might be a CDL reference – care must be taken to correctly identify the reference. The textual wording of the defect must match that recorded against the defect in the MEL/CDL.

11.21. DDG/MEL Dispatch with the "M"

Firstly, a quick overview of the application of the DDG/MEL between Pre-flight and Takeoff.

- The point of "Dispatch" is defined in the A1 and DDG and is when the last cabin door closes. From this point on the DDG/MEL technically becomes "guidance" for the PIC.
- Between Dispatch and Takeoff, the aircraft will return if the operation is deemed unsafe or "inappropriate" by the Pilot in Command with the failed equipment – even if continuation of flight is allowed by the DDG/MEL as a dispatch item.
- Finally, if the defect that occurs between Dispatch and Takeoff has an MEL with a Maintenance (M) requirement – the PIC must return to stand and have the MEL applied.

This seems pretty straight forward, and clearly defects that don't have an "M" are likely to be those with little consequence for the continuation of flight, surely. Well … let's look at an example.

❑ PACK L/R between Dispatch & Takeoff

This is certainly not an unfamiliar failure to most crew, since it's used during simulator inflight quite regularly, and often during taxi in cold weather to increase the pressure of a holdover time requirement (nasty!).

This defect does not have a Maintenance Procedure (M) in the MEL. But this omission does not imply a lack of complexity nor impact of this failure on continued flight.

Virgin australia

Section 2 **777 Dispatch Deviations Guide**

21-51-01 **Air Conditioning Packs**
21-51-01-04 **Single Pack**

Interval	Installed	Required	Procedure
C	2	1	**(O) [E] [P]**

PACK L/R has Operational (O) and Performance (P) requirements – but no (M). The lack of (M) releases the PIC on the day from the dictates of the DDG after "Dispatch" – but not from the dictates of Common Sense. If you lost a Pack on taxi, which flights would you consider continuing? Long Haul? Short Trip? Diversion Recovery? Empty (short) Ferry?

❑ PACK L/R Operational Implications

Another consideration for this specific defect (*and all defects with a DDG/MEL entry*) are the Operational requirements. Even if this failure occurs after Dispatch – or airborne – you still need to consider some or all of the following items abbreviated from the current DDG/MEL entry.

- Aft/Bulk Caro Heating may be affected (~13° with "High")
- PACK L : No APU to Pack; and associated Crew Rest Area temperature control can be affected
- **FIRE CARGO FWD/AFT** : With single pack, descend to FL330 after the NNM; Position both EAI Selectors ON at top of descent
- For OFCR smoke (SMOKE REST UPR DR 1) – **AFT/BULK CARGO TEMP** selectors … **OFF**

Remember, the DDG/MEL is "Guidance" after "Dispatch"!

11.22. Pre-Start Hydraulic Pressurisation

The pre-flight Hydraulic Panel pressurisation sequence should be performed exactly as documented in the FCOM. Typically it's worth noting that:

- The C1 ELEC PRIMARY is selected before the C2 ELEC PRIMARY. As well as being in the order specified by the FCOM procedure, this ensures that the C2 pump is not pressurised needlessly during the flow.

This procedure is primarily formulated to prevent fluid transfer from the Center to the Right hydraulic systems. Such a fluid transfer could potentially take place through the brake accumulator system if the hydraulic systems are pressurised out of sequence, although the mechanism of transfer is not documented by Boeing.

HYDRAULIC panel .... Set F/O

WARNING: If the tow bar is connected, do not pressurize the hydraulic systems until the nose gear steering is locked out. Unwanted tow bar movement can occur.

Note: Pressurize the right system first to prevent fluid transfer between systems.

Right ELECTRIC DEMAND pump selector .... AUTO

Verify that FAULT light is extinguished.

Center 1 and Center 2 ELECTRIC PRIMARY pump switches ON

Verify that the Center 1 FAULT light is extinguished.

The Center 2 FAULT light may stay illuminated until after engine start because of load shedding.

Left ELECTRIC DEMAND pump selector .... AUTO

Verify that the FAULT lights are extinguished.

Center 1 and Center 2 AIR DEMAND pump selectors ...... AUTO

Verify that FAULT lights are extinguished.

11.23. Application of CDL Performance Limits

The aircraft CDL (*contained in the DDG*) allows dispatch with airframe/aerodynamic defects and in some cases includes performance penalties that affect one or more phases of flight.

TLDC - CDL Takeoff/Landing Performance Penalties

TLDC will account for CDL performance penalties in the Takeoff, Approach/Landing Climb, Landing and Landing Field Length cases if the appropriate CDL defect has been selected/entered in the request.

Most of the CDL defects that come with takeoff/landing performance limits affect only the ***performance limit***. As such typically a CDL defect may have no impact on the resulting takeoff weight of the aircraft.

That said there are CDL items that must be applied to the ***Certified*** weight limits, irrespective of any performance penalties (*see CDL 57-31-03*). TLDC observes both the performance and/or certified limit penalties in the performance calculations.

57-31-03 Raked Tip

Both raked wing tips may be missing provided:

1. Increase VR, V2 and VREF speeds by 2 knots.
2. For raked tip removed, refer to Cruise Maneuver Capability charts (kg) on the following pages.
3. Night time operation with the raked wingtips removed is prohibited.
4. Reduce Takeoff performance limited weights by 11,385 kg.
5. Reduce Landing performance limited weights by 26,081 kg
6. Reduce Enroute Climb performance limited weights by 5,307 kg.
7. Reduce Maximum Quick Turnaround limited weights by 3,129 kg.
8. Observe the following Maximum Gross Weight limits:
   A. Taxi Weight is 300,277 kg.
   B. Takeoff Weight is 299,370 kg.
   C. Landing Weight is 237,682 kg.
   D. Zero Fuel Weight is 224,528 kg.
9. Observe Aft Centre of Gravity limit of 38.5% MAC for weights above 287,123 kg.
10. Reduce maximum operating altitude (thrust or buffet limit) by 1,000 feet.

Additionally, the CDL introduction should be consulted for dispatch with multiple CDL defects, and provides detail on:

- The cumulative (or not) nature of multiple defects.
- Limitations to apply to multiple defects with "negligible" performance penalties.
- Specific decrements against certified Taxi, Takeoff, Landing, Zero Fuel and Max Quick Turnaround limit weights.

Enroute performance penalties may need to be applied to the CFP PDA (Fuel/Drag) penalties when dispatching with a CDL defect. The CDL introduction provides detail on this, and Dispatch should be consulted. See **Enroute CDL Performance Penalties** for the practical application of checking enroute performance penalties in flight.

11.24. ACARS Notification of LMCs

Flight crew are responsible for changes to the Computer Loadsheet once it has been issued. Last Minute Changes (LMC) can be accepted to a limit of **± 250Kg / ± 2 Pax** (including associated bags) updates must be sent to Load Control via ACARS COMM MESSAGE TO GROUND using a specific format.

Pax with/without Checked Baggage : (M)ale [125 kg]; (F)emale [125 kg]; (C)hild [125 kg]; (I)nfant [0 kg]; (B)ag [15 kg]

Note that changes up to ± 1000Kg / ± 1.5% MAC can be accepted in concert with Load Control when Curfew or Flight Crew Duty Limits are at stake. For LMCs to a manual Loadsheet – refer to the A1. Note these values are different from the domestic operation.

- LOAD	Message to Load Control	**- LOAD**
LMC -1F ZA +1M ZD	-1 Female from Zone A; +1 Male into Zone D	**LMC POTABLE WATER FULL**
1234	Captain Staff Number	**1234**

11.25. APU to Pack in High Temps

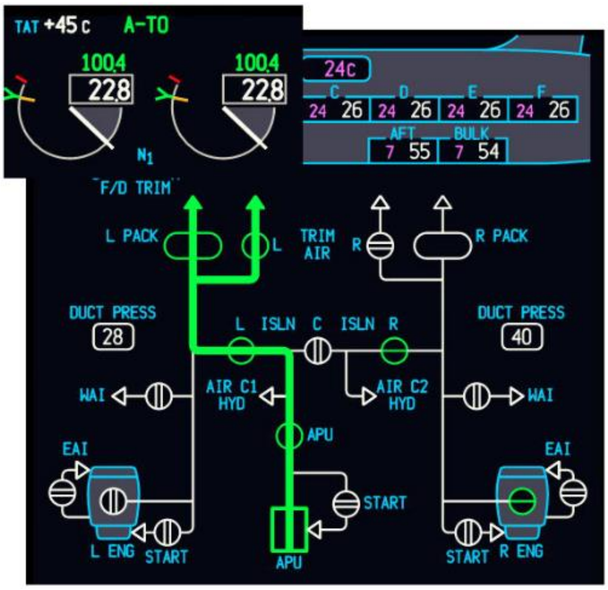
The FCOM SP on APU to Pack Takeoff includes a note advising that extended taxi in single pack configuration can result in excessive temperatures. It doesn't highlight of course that typically an APU to Pack departure is the result of operation at heavy weights (high passenger load) in high ambient *(performance limiting)* temperatures. Hence excessive cabin temperatures are probably to be expected in all but the shortest taxi for departure.

APU to Pack Takeoff

Note: If cabin temperature becomes excessive during extended ground operation, establish dual pack operation by deleting the APU selection. To re-establish APU to Pack operation, enter "APU" into the scratchpad and line select to the "SEL-APU" field.

While the SP makes it sound simple – in fact deleting the APU setting from the thrust limit page will drop the takeoff speeds from the FMC. Typically, this item is covered in the departure briefing so the crew expect it. In the event that this is required:

- Anticipate the requirement and restore two pack operation early if required after single pack configuration has been established (*second engine start*).
- Leave the **TAKEOFF SPEEDS DELETED** message in the scratchpad and delay the Departure Review and Before Takeoff Checklist until the speeds are re-entered.
- Complete the Final FMC Takeoff Performance Data Entry procedure to restore the speeds, checking all values remain. Anticipate a good two minutes to restore APU to Pack operation with all takeoff data entered/checked correctly.



Some crew decide when briefing the departure that instead of having to enter the information twice – they will instead delay the Final FMC Performance Entry procedure until they are nearing ready for Takeoff. Hence, they start/push back without the FMC complete, establishing takeoff data and single pack operation only as they near the runway. This procedure is NOT recommended by Training/Standards. Instead complete all normal pre-departure data entry and if deleting APU to Pack as required – ensure you re-run data entry in full.

Or … Consider a Packs OFF Takeoff.

11.26. FMC Track/Distance Checking – Oceanic, Lat-Lon, Off Airway Waypoints

The route of flight must be checked by both pilots independently during pre-flight. In addition to this, any route segments involving latitude/longitude waypoints also require a track/distance check of CFP against FMC LEGS page data. This check should also be done on segments using off airway waypoint to waypoint tracking in Oceanic Space, even if no lat/lon waypoints are involved.

Tolerance should be within ±3° Track and ±2 nm between the FMC LEGS page and the CFP Navigation Log pages.

AWY FIR LSALT	POSN LAT LONG	FL CLB+	WIND TDV TEMP	MTR TTR	DIST REMD	TAS MACH GS	ETI ACTM REMT	ETA RETA ATA	A FREM P FREM MINR	F USED FOD
DCT 1500	[illegible] [illegible] W158 00.0	[illegible]	M[illegible] ISA+[illegible] M40	[illegible] 219	[illegible] 4170	[illegible] [illegible] 488	[illegible]:47 [illegible]:59 09:07		 70277 67695	
DCT 1700	(EA4) N01 55.2 W161 05.0	340	M12 ISA+9 M43	216 225	260 3910	[illegible] 83 478	[illegible]		[illegible] [illegible] 63399	
DCT 1500	00N63 N00 00.0 W163 00.0	340	M4 ISA+10 M42	216 225	164 3746	[illegible] 83 486	00:20 06:52 08:14		 63355 60773	
DCT NZZO 1500	DUNEY S05 00.0 W168 58.1	[illegible]	M4 ISA+11 [illegible]	220 [illegible]	467 3279	490 83 486	00:57 07:49 07:17		 55968 53386	
DCT 1500	(EA5) S06 22.5 W171 01.0	[illegible]	[illegible] ISA+12 M40	[illegible] 236	147 3132	486 82 494	00:18 08:07 06:59		 53730 51148	

Off Airway

Track Consistent ± 3°

Distance Summed ± 2nm

Lat/Lon Check

There is no requirement for an independent/double cross check on tracks/distances. This check is in fact best done by the two operating crew working together with the FMC against CFP.

Standard CFP Notation for Lat/Lon Oceanic Waypoint Checking

When the Track/Distance checking is performed of the CFP against the FMC LEGS pages, it is recommended that verified Track and Distance be ticked off on the Master CFP. In addition, either the Waypoint Name (for named waypoints) or the full Latitude/Longitude naming be ticked as well.

11.27. Re-Clearance Flight Plans & Final ZFW

Re-clearance flights plans are utilised when the need to maximise payload against a limiting takeoff weight exists – whether a performance or certified limit. Re-clearance flight plans are also possible against a volumetric fuel capacity limit as well. The increase in payload comes at the expense of contingency fuel and the Company accepts the statistical increase in the likelihood of a diversion as the result of dispatching the flight with minimal fuel.

The essential concept is that the flight is planned to a fixed point short of the destination, and from that point a re-clearance CFP is provided to an enroute airport that requires less fuel overall than continuing to destination. In this way the flight can be dispatched to destination legally with less than standard contingency fuel - down to an A1 minimum of 2000 Kg.

VOZ 24
KLAX - YMML

	TIME	FUEL
TRIP	15:09	125394
CONT	00:14	2000
DEST TFC	00:00	0
DEST WX	00:00	0
ALTN YMAV	00:23	2831
ALTN WX/TFC	00:00	0
FXD RES	00:30	2928
ETP B/U	00:00	0
RCL B/U	00:00	0
MIN REQD	16:16	133153

Note the Departure -> Re-Clearance WayPoint -> Alternate has its own contingency fuel requirements defined in the A1.

It's worth noting that dispatch using re-clearance contingency fuel in combination with the fuel-closest alternate can result in low estimated (*and actual!*) fuel remaining at destination, which comes with its own implications for in-flight arrival planning.

RECLEARANCE SUMMARY

DIVERSION TO **YSSY** FROM **RAZZI**

FROM	TO	DIST	AVG W/C	FL	TRIP	FOB	FUEL RQD	EET	ETA
KLAX	RAZZI	6623	M33	360		11118	-----	14:21	18:31
RAZZI	YSSY	166	P3	360	1238		4228	00:30	19:01
RAZZI	YMML	311			3348		11107	0:48	

FUEL RQMNTS **YSSY** INCLUDE WX+TFC HOLDING **0** MINS **0** KGS

The re-clearance airport is not planned with (*fuel for*) an alternate unless the forecast weather is below the alternate planning minima (*not landing minima*) as defined in the A1.

In flight the crew decide prior to the re-clearance point as to whether they will be able to continue on to destination or will be required to divert to the re-clearance airport. Remember that after dispatch, contingency fuel is not required; only the Minimum Required (MINR) value must be achieved at the re-clearance waypoint to continue on to destination – and even that figure can be re-calculated in flight to maximise the potential of continuing to destination.

Pre-Flight : Restoring Contingency

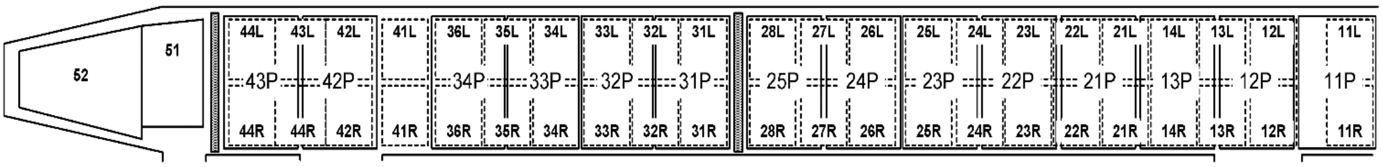
Be aware that in this situation the CFP should be constructed – and final fuel calculated by the crew – to increase the contingency up to the standard planning figure of 20 minutes as much as practicable.

- If the CFP is planned with minimum 2000 Kg contingency but below the relevant performance limit (M.TOW? M.LDW?), crew should consider increasing final fuel towards the relevant weight limit to recover some contingency fuel.
- If the final ZFW drops below the planned figure – final fuel should be increased to recover as much of the 20 minutes contingency fuel as practical.

Re-clearance dispatch comes with an inherent statistical increase in the likelihood of a diversion. When sufficient fuel exists at the re-clearance point to continue on to destination crew are then placed in the circumstances of arriving into destination with very little fuel in excess of that required to divert to alternate – commitment to destination is very likely in this scenario.

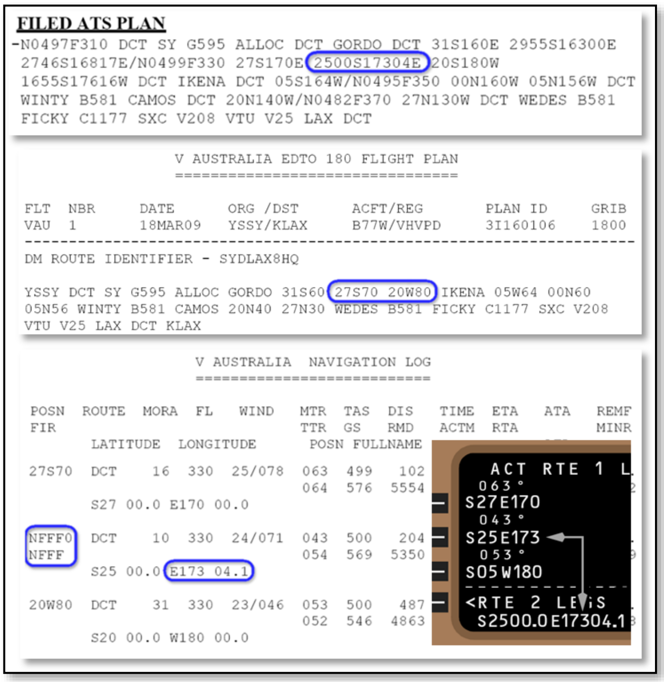
11.28. NOTOC – Cargo Positions

The NOTOC includes the location of dangerous/special load in terms of either Pallet (P) or ULD (L) loading. While the diagram of the 777 cargo hold exists in a few places, the locations are not hard to remember (1/2=FWD; 3/4=AFT; 5=Bulk).



11.29. FMC vs CFP Lat/Lon Waypoints and Positions

The FMC Pre-flight requires both crew to independently verify the uplinked/entered FMC route against the CFP.



```
FILED ATS PLAN
-N0497F310 DCT SY G595 ALLOC DCT GORDO DCT 31S160E 2955S16300E
 2746S16817E/N0499F330 27S170E 2500S17304E 20S180W
 1655S17616W DCT IKENA DCT 05S164W/N0495F350 00N160W 05N156W DCT
 WINTY B581 CAMOS DCT 20N140W/N0482F370 27N130W DCT WEDES B581
 FICKY C1177 SXC V208 VTU V25 LAX DCT

              V AUSTRALIA EDTO 180 FLIGHT PLAN
              ================================

FLT  NBR      DATE      ORG /DST      ACFT/REG      PLAN ID     GRIB
VAU  1        18MAR09   YSSY/KLAX     B77W/VHVPD    3I160106    1800
--------------------------------------------------------------------
DM ROUTE IDENTIFIER - SYDLAX8HQ

YSSY DCT SY G595 ALLOC GORDO 31S60 27S70 20W80 IKENA 05W64 00N60
05N56 WINTY B581 CAMOS 20N40 27N30 WEDES B581 FICKY C1177 SXC V208
VTU V25 LAX DCT KLAX

              V AUSTRALIA  NAVIGATION LOG
              ===========================

POSN  ROUTE  MORA  FL   WIND    MTR  TAS  DIS   TIME  ETA   ATA   REMF
FIR                             TTR  GS   RMD   ACTM  RTA         MINR
      LATITUDE  LONGITUDE       POSN FULLNAME

27S70  DCT    16   330  25/078  063  499  102
                                064  576  5554
      S27 00.0 E170 00.0

NFFFO  DCT    10   330  24/071  043  500  204
NFFF                            054  569  5350
      S25 00.0 E173 04.1

20W80  DCT    31   330  23/046  053  500  487
                                052  546  4863
      S20 00.0 W180 00.0
```


Lat/Lon Waypoint Line Selection

When a route includes Lat/Lon waypoints, this verification must include line selection of these waypoints into the FMC scratchpad. The FMC displays all lat/lon waypoints using an abbreviated **N26E179** format whether crossing exact meridians/parallels or not. Scratchpad verification is the only way of ensuring accurate lat/lon FMC values.

The PM/PF must line select each Lat/Lon waypoint into the FMC scratchpad to verify accuracy against the CFP.

Route Checking

FCOM NP Route checking consists of a basic Airway/Waypoint cross check between the CFP and the FMC. If uplinked, both pilots independently check the result. If manually entered – the second pilot checks the first pilot's work. There are two recommended CFP pages for route checking.

- CFP Filed ATS Plan page; or
- CFP Navigation Log pages.

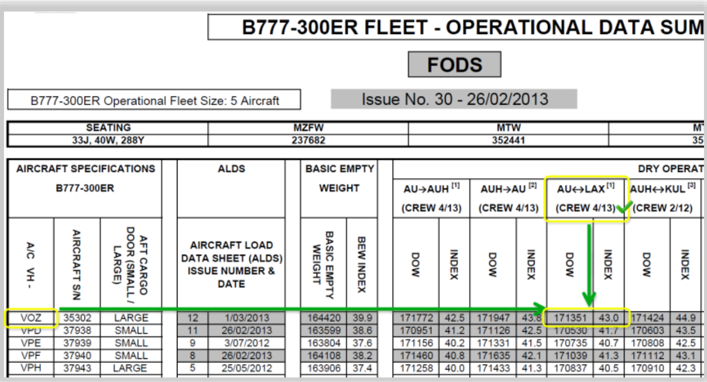
CFP ATS Plan : The CFP ATS page summarises the route into airways/airway crossing waypoints and is normally the most efficient for cross checking the CFP against the FMC RTE pages. However, lat/lon waypoints may not be of sufficient detail on the ATS page for accurate checking and no track/distance information is available.

CFP Navigation Log : The Navigation Log page provides a full representation of the flight plan including detailed lat/lon waypoint and true/magnetic tracks and distance. However, the Nav Log can contain extraneous waypoints such as FIR crossing boundaries that are not uplinked to the FMC, or in the ATS plan. Additionally, the Nav Log can be cumbersome when checking airway/airway intersection waypoints against the FMC RTE pages.

It should be noted that in some instances the CFP abbreviates latitude/longitude waypoints into a format that is not acceptable for cross checking or manual entry into the FMC (eg **27S70**) in the route description on the main CFP page.

11.30. Aircraft DOW & DOI

The Captain is usually required to verify the DOW and DOI on the load sheet (*amongst other things*) as part of load sheet acceptance.



B777-300ER FLEET - OPERATIONAL DATA SUM

FODS

B777-300ER Operational Fleet Size: 5 Aircraft — Issue No. 30 - 26/02/2013

SEATING 33J, 40W, 288Y — MZFW 237682 — MTW 352441

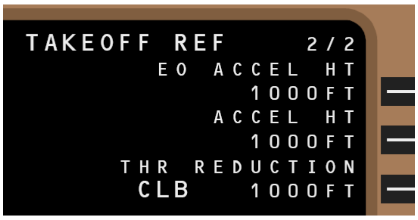
A/C VH -	AIRCRAFT S/N	AFT CARGO DOOR (SMALL / LARGE)	ALDS ISSUE NUMBER	ALDS DATE	BASIC EMPTY WEIGHT	BEW INDEX	AU→AUH [1] (CREW 4/13) DOW	INDEX	AUH→AU [2] (CREW 4/13) DOW	INDEX	AU↔LAX [1] (CREW 4/13) DOW	INDEX	AUH↔KUL [3] (CREW 2/12) DOW	INDEX
VOZ	35302	LARGE	12	1/03/2013	164420	39.9	171772	42.5	171947	43.8	171351	43.0	171424	44.9
VPD	37938	SMALL	11	26/02/2013	163599	38.6	170951	41.2	171126	42.5	170530	41.7	170603	43.5
VPE	37939	SMALL	9	3/07/2012	163804	37.6	171156	40.2	171331	41.5	170735	40.7	170808	42.5
VPF	37940	SMALL	8	26/02/2013	164108	38.2	171460	40.8	171635	42.1	171039	41.3	171112	43.1
VPH	37943	LARGE	5	25/05/2012	163906	37.4	171258	40.0	171433	41.3	170837	40.5	170910	42.3

The DOW/DOI for the various aircraft/route combinations include Basic Aircraft, Potable Water, Crew Complement (*with or without crew checked baggage*) and relevant Pantry Code. Note that the basic DOW/DOI includes full potable water and the crew will need to check for a Loadsheet adjustment for the instances when dispatching with 7/8th of the potable water tank, depending on the level of accuracy required.

Adjustments are typically only required for non-standard Crew Complement. Remember to notify Load Control of a non-standard crew complement by at least the time the Final ZFW is received to ensure an accurate load sheet.

A significant difference between the Load sheet and Crew calculated DOW/DOI should be explored and if appropriate, reported in a Flight Crew Report. When investigating differences, remember to check the ALDS version with Load Control ...

11.31. Noise Abatement - FMC TAKEOFF REF P2/2



The three values of Engine Out Acceleration Height (**EO ACCEL HT**), All Engine Acceleration Height (**ACCEL HT**) and All Engine Thrust Reduction Height (**THR REDUCTION**) on the FMC TAKEOFF REF page 2/2 are referenced to the departure runway elevation and are derived from a combination of airline policy, noise abatement and engine out takeoff performance requirements.

It should be noted that the small font representation of these values in the FMC indicate the Airline Policy defined defaults. If these values are correct there is no need to "harden" them up by manually entering large font values. ***Boeing – why can't I line select these values into the scratchpad?***

Airline Policy

Standard airline departure profile in the absence of specific noise abatement requirements is 1000/1000/1000. These values need to be verified by the crew during pre-flight and adjusted for any noise abatement procedures (NAP) in force, or non-standard engine out acceleration height.

There is a minimum value of 1000 ft AAL for All Engine/Engine Out Acceleration and Thrust Reduction – irrespective of any noise abatement requirement.

Noise Abatement Profiles – NADP1 / NADP2 (and ICAO A & B)

There are two ICAO Noise Abatement Procedures (NAP) documented in the A1 and Jeppesen – NADP1 and NADP2.

An airport/regulatory agency may specify the use of one of these two procedures, in which case crew should enter FMC settings to comply with the requirement. When the airport/regulatory agency specifies a Noise Abatement requirement without a specific profile – the crew have the ability to choose either NADP1 or NADP2. In some cases, Flight Operations may recommend one particular NAP for a specific airport/runway (eg: YSSY RW34L NADP2) – this will be documented in Jeppesen and/or TLDC.

	Standard	NADP1	NADP2	ICAO A	ICAO B
EO ACCEL [1]	1000 (TLDC value if higher)				
ACCEL [1]	1000	3000	1000	3000	1000
THR REDUCTION [1]	1000	1000	Flap 1/5 [2]	1500	Flap 1/5 [2]
Then UP Speed to	-	-	3000 [3]	-	3000 [3]

[1] Increase to at least EO ACCEL as required by TLDC.

[3] Where appropriate, maintain UP speed to 3000 ft AAL.

[1] **EO ACCEL (TLDC)** is a minimum height for all EO ACCEL / ACCEL / THR REDUCTION entries, irrespective of NAP.

[2] **NADP2/ICAO B** requires thrust reduction with the first stage of flap retraction during the acceleration segment. This is enabled through the FMC CDU TAKEOFF REF Page 2/2 by entering the flap selection that is one less than the takeoff flap selection. Note that a subsequent change of takeoff flap setting may require an update of the entered CDU THR Reduction Flap setting. While common practice is to enable this through the thrust reduction altitude (1000) – this is not technically in compliance with ICAO NAP specifications.

Takeoff Flap	CDU Thr Reduction
5°	1
15°	5
20°	5

[3] NAPs that specify acceleration below 3000 ft AAL usually require V_{ZF} (*Flaps Up Speed*) to 3000 ft AAL – which may also require either MCP Speed Intervention or a FMC VNAV Climb Page speed/altitude restriction to comply at lighter operating weights.

Note that the NADP1 specification is minimum/maximum altitudes and as such the values are occasionally interpreted differently by various airlines/regulatory authorities.

The B777 FMC can schedule a second segment climb speed (*all engine*) up to V2+25 knots. This is considered acceptable for the purposes of noise abatement.

Finally, some airfields give specific a NAP, typically based on out of date procedures such as **ICAO-A** or **ICAO-B**. Accordingly crew should make FMC selections to follow these profiles. Remember that any specified <u>altitude</u> requirements will have to be converted to <u>heights above runway</u> prior to entry into the FMC TKOFF REF P2/2.

Engine Out Acceleration Height

Airline standard engine out acceleration height is 1000 ft AAL. TLDC may specify a height in excess of this, in which case all three height values on FMC TAKEOFF REF P2/2 should reflect this height increase.

For example, if Noise Abatement is not required and the TLDC ACEL HT is 1130 ft, FMC **EO ACCEL HT**, **ACCEL HT** and **THR REDUCTION** should all be set to **1130**

11.32. Aircraft Temperature during Pre-Flight

The 777 is pretty good at keeping the cabin cool on warm days. Working against this is the excessive implementation of the term "warm days" found at ports such as Abu Dhabi where the ambient temperature can rise well above 40°C in combination of high levels of humidity approaching and including fog; the insistence of keeping several cabin and cargo doors open during pre-flight under the pre-text of loading; and the body heat of 350+ human beings in close proximity. There's guidance in the FCOM SP Adverse Weather – Hot Weather Operation. However, this information is focussed on the Flight Deck (*nothing wrong with that!*).

Hot Weather Operation

During extended ground operations prior to flight deck preparation, consideration should be given to reducing the heat being generated on the flight deck. Window heat, radar, and other electronic components which contribute to a high temperature level on the flight deck may be turned off. All the flight deck air outlets should be open.

Both packs should be used (when possible) for maximum cooling. Recirculation fans should be on for maximum cooling capacity. To maximize the cooling capacity of the air conditioning system, the flight deck side windows and all doors, including cargo doors, should be kept closed as much as possible. All gasper outlets should be open and window shades on the hot (sun–exposed) side of the passenger cabin should be closed. Flight deck cooling can be improved by closing the flight deck door and lowering the side trays adjacent to the pilot seats.

Note: If only cooling air from ground air conditioning cart is supplied (no pressurized air from the APU or ground external air), then the TAT probe is not aspirated. Because of high TAT probe temperatures, the FMCs may not accept an assumed temperature derate. Delay selecting an assumed temperature derate until after bleed air is available.

Recirculation Fans

It is readily acknowledged that the prime function of the Recirculation Fans in cruise is to mix and distribute airflow, reducing the load on the Packs and thereby reducing fuel consumption. As such we are often asked whether turning off the Recirculation Fans on the ground on warm days produces better cooling.

Upper Reciculation Fans … OFF?

In fact, when operating off the APU on ground during pre-flight, maximum cooling capacity is normally attained by operating with the Lower Recirculation Fans ON and the Upper Recirculation Fans OFF, but this mode may reduce the cooling flow available to the passenger cabin. The pack flow is limited on hot days by the ability of the APU to deliver bleed air. As the ambient climbs above 27°C the APU limits bleed air to keep APU operating parameters below the redline limits. The pack discharge temperature is limited to about 2°C by the temperature sensor in the mix manifold and is predominantly determined to limit the formation of ice in the upper manifold and ducting. With the Upper Recirculation Fans OFF, the cooling pack discharge temperature is improved to approximately 0.5°C to attain the 2°C control reading at the mix manifold temp sensor.

The decision to turn off the Upper Recirculation Fans is usually left to the airline. Turning these ON takes the heat load from the top of the aircraft and transfers this heat to the cabin with no increased cooling from the packs. If however your aircraft is equipped with above cabin deck crew rest that is used for taxi/takeoff, the upper Recirculation Fans must be left ON if the crew rest is (to be) occupied.

Lower Reciculation Fans … ON

When the Lower Recirculation Fans are ON, warm/hot cabin air is introduced into the bottom of the mix manifold by the lower fans, and the packs must discharge much cooler air into the mix manifold. With the lower fans on, the packs must go below freezing to maintain the 2°C mix manifold discharge temperature. This causes the packs to provide more cooling capacity to the cabin.

In summary – there is approximately a 60% increase in airflow to the main cabin with the Lower Recirculation Fans ON during hot weather. The operating configuration of 2 packs and the 2 lower recirculation fans maximises cooling to the main cabin and flight deck.

Cabin Doors

There is an obvious and a less obvious reason for minimising cabin doors open during pre-flight hot weather operations. Closed Cabin Doors prevents hot ambient air from exchanging with the cooler cabin air and slowing the cooling of the cabin. Additionally, with the cabin doors open, ambient air enters the cabin and is ingested into the Lower Recirculation Fans. If moist air reaches the Recirculation Fans, ice can develop in the bottom of the mix manifold where sub-freezing pack air meets moist recirculation air. Such ice may block ducting and slow the cooling of the flight deck and cabin after 45 minutes or more of cooling time.

11.33. FMC Initialisation with ACARS Uplink

Boeing do not document an FMC Initialisation procedure via Datalink. As such the procedure published here is advisory only.

Currently we uplink the **Route**, **Flight Number**, **Route Winds**, **Descent Forecast Winds** and **ACARS COM Company Flight Information** page. PERF INIT and TAKEOFF REF data is not uplinked and needs to be manually entered by the crew from the CFP.

The overview of this process is to uplink, load and where necessary activate and/or execute the Route, Flight Number, Route Winds and Descent Forecast Winds.

Delays in loading, activating and executing the various components can result in buffer overruns, particularly in respect of multiple wind uplinks. Each time the FMC has completed a stage - move on with the uplink process.

Once uplinking is complete, the crew member should complete the conventional Boeing FCOM documented FMC initialisation procedure. During this follow up procedure, entries should be verified as uploaded correctly (against the CFP) or entered where incorrect or missing.

Once the FMC pre-flight initialisation is complete, the ACARS COM Company Flight Information page should be completed to enable automatic movement messages (Out, Off, On, In). These automatic messages are in addition to the required manual **Departure** and **Arrival** reports.

The process of uplinking the initialisation components can take several minutes with interruptions as the Route and Winds are uplinked; loaded; activated & executed (where necessary). Note that wind uplink is part of the Route Request – a subsequent Wind Request should not be necessary.

Crew may commence the uplink procedure; then commence other activities while waiting for the uplinks & loads to complete. The **FMC COMM** page should be checked for **Data Link Ready** in the event that there is doubt about a connection. Remember the ADIRU must be aligned for SATCOM link; VHF-C should be in **DATALINK** to enable VHF Datalink and minimise Satcom costs.

FMC Datalink Initialisation Procedure

INIT REF **IDENT Page** .... **Select**

IDENT Page .... **Verify**

Verify MODEL ***777-300.2***
Engine Rating........ ***GE90-115BL***
Active Nav Data Base........ **Check Date**
Drag/FF correction factors .... **Against CFP**

NAV DATA> NAV RAD INHIBIT........ **ON**

POS INIT > line select key .... **Push**

Time .... **Verify Correct**

Inertial Position........ **Enter**

Enter position using the most accurate lat/lon available (GPS).

FMC COMM key........ **Push**

DATALINK READY .... **Verify**

Note: ***VHF-C should be in DATA*** *to minimise ACARS costs. IRS Alignment is required for ACARS via SATCOM to function.*

< RTE 1 line select key........ **Push**

< ROUTE REQUEST line select key .... **Push**

Note: *This initiates a data link request for a Route, Flight Number, Enroute/Descent Winds and ACARS Initialisation page.*

< LOAD line select key *(When **<LOAD** prompt appears)*........ **Push**

ACTIVATE> line select key *(When **ACTIVATE>** appears)*........ **Push**

EXEC key *(When **Execute** Light illuminates)* .... **Push**

FMC COMM key........ **Push**

Verify All Uplinks are loaded........ **Enter**

(Small Font Uplink indicates pending data)

LOAD : **Winds :** **FMC COMM** : **< WIND, LOAD** & **EXEC**
Desc Winds : **FMC COMM** : **< DES FORECAST, LOAD**

Standard FMC Initialisation .... **Commence & Complete**

Note: *Virgin Australia SOPs prohibit the entry of the following items during Pre-Flight FMC Initialisation:*
***ZFW, Engine Out Acceleration Height, CoG, Selected Thrust** & **De-Rate, Flap Selection, Takeoff Speeds**.*

11.34. Use of Delta Burn, PS1000, MS1000 fuel correction figures

Long Haul fuel burns are significantly affected by changes in departure weight, to the point where a 1000Kg increase in cargo load can require an additional 500Kg in fuel to preserve the planned Fuel Over Destination (FOD).

Three figures to correct fuel load are provided on the Flight Plan – the Delta Burn, and the TOW PS/MS values. Staring in the reverse order to which these are provided on the plan …

Takeoff Weight Change – PS/MS 1000 Kg

CONTINGENCY SUMMARY		
CASE	TIME	TRIP
TOW PS1000	NO CHANGE	307 KGS
TOW MS 1000	NO CHANGE	-284 KGS

This correction is the simplest to understand. For the flight depicted, an increase in Takeoff Weight will increase the resultant fuel burn (*if no other changes are made*) by 307 Kg. Note this is any increase in TOW whether it be Cargo, Passengers or additional Fuel. The reverse holds true for reductions in TOW. That seems simple enough …

The complexity comes in when the crew desire to retain the planned Fuel Over Destination. If the TOW increases 1000 Kg, the Trip Fuel increases 307 Kg - all else being equal, the arrival fuel decreases 307 Kg. Since long haul flights are typically planned within minimum fuel, this means additional fuel must be carried to preserve the original FOD. So, just adding 307 Kg should solve the problem, right?

Unfortunately, increasing the Fuel Load 307 Kg also increases the TOW 307 Kg, which increases the Fuel Burn by (307/1000)*307 = 95 Kg. Ok, so we just add another 95 Kg – except that an additional 95 Kg increases the TOW by … The solution to this is the Delta Burn figure.

> **A1 A1.1 FLIGHT PLAN DECODE**
>
> **Delta Burn / 1000 KG**
>
> The increase or decrease in TRIP fuel required to adjust the LDW by +/- 1000 kg. The change in LDW may comprise changes in ZFW and/or fuel.
>
> - If the ZFW changed from flight plan and the planned FOD is required, then the TRIP fuel can be adjusted using this delta.
> - If the FOD desired is different to flight plan, then the TRIP fuel can be adjusted using this delta.
>
> **Take Off Weight (TOW) PS/MS 1000**
>
> The change in TRIP time and TRIP fuel if the planned TOW changes by +/- 1000 kg. The change if TOW may comprise changes in ZFW and/or fuel.
>
> - If the ZFW changed, and no change to FOB was desired, then the TRIP fuel can be adjusted using this figure.The increase or decrease in TRIP fuel required to adjust the LDW by +/- 1000 kg. The change in LDW may comprise changes in ZFW and/or fuel.

Delta Burn / +1000 Kg

DELTA BURN/1000KG LDW	402

The flight planning system has thoughtfully gone ahead and iterated this problem for you. In this instance, an increase in TOW results in an increase in Fuel Required of 402 Kg to preserve the FOD. This is sold on the flight plan as a Delta Burn against changes in Landing Weight (LDW). **In fact, this figure is only relevant against *<u>increases</u>* in Landing Weight** (*or Takeoff Weight carried through to Destination*). Currently the flight planning system does not provide a Delta Burn figure for weight reductions.

While the A1 provides an example of a ZFW change scenario, the Delta Burn figure would also be relevant for increases in Fuel Load when you want to carry that fuel to destination.

Examples (using the above figures)

- If your ZFW increase 2500 Kg, the Ramp Fuel must be increased by (2.5 x 402) = 1005 Kg. While the A1 suggests using the Delta Burn to change your Trip Fuel (2.5 x 402) = 1005, a more accurate figure probably results from applying the PS1000 figure to your change in TOW ((2.5 + 1) x 307) = 1075. That said, the difference is typically small and the Delta Burn figure is already calculated and is pretty close.
- If you decide you need additional fuel, and that fuel is required at your Destination (or Alternate) then the above solution provides the correct result.
- If you plan to carry additional fuel for enroute use, then simply adding the fuel required, then correcting the Trip Fuel using the PS1000 figure provides an accurate result.
- Solutions involving changes in ZFW, changes in Extra Fuel in combination require VooDoo magic and are not directly supported by the figures provided. As such – it is suggested you err on the conservative side …
- Remember TOW changes in excess of 3000 Kg come with the option of ordering an updated (ACARS) flight plan to get a more accurate solution, if OTP permits.

Conclusion

There are a couple of things missing here. Firstly – and most importantly, while the Delta Burn figure is based on the PS1000 value – often the difference between PS1000 and MS1000 can be significant. Since the MS1000 is generally a smaller change in Fuel Burn, this means that for large drops in ZFW, the Delta Burn figure can take off more fuel than is justified by the dispatch weight change.

Secondly – combinations of Load followed by changes in Ramp Fuel for reasons other than Load become complicated and not really worth the agro on the flight deck of determining an exact value – come up with a reasonable, conservative result and go with that.

11.35. Using DELTA BURN To Calculate a Change in ZFW based on RAMP Weight Change

While not supported by the A1, the Delta Burn figure can be used to calculate a **Change in ZFW based on a required change in the aircraft Takeoff Weight**. A classic scenario requiring such a solution is the crew arriving at the aircraft to discover that they have been flight planned in excess of the Performance Limited Takeoff Weight. Typically seen in Los Angeles when tailwind and/or runway works are factors; or in Melbourne during Summer with a northerly breeze – the result can require a reduction in Load (*Cargo, Pax Bags, Pax, Fuel*) to achieve a Performance Takeoff Weight Limit. **Ideally the best solution to this problem is a new ACARS flight plan based on the change in ZFW**, but when that's not immediately to hand, a reasonably accurate figure can be determined as follows.

In this example the flight planner had already gone with a TOW limit of 340 Tons, subsequently the crew have determined a more practical limit of 333 Tons. The complication is that some of the 7000 Kg will be reduced Load, and some a reduction in the Trip Fuel required to carry that reduced Load. By definition, this is a Delta Burn calculation (see **Use of Delta Burn, PS1000, MS1000 fuel correction figures**), but in reverse.

In the end, a new flight plan will be required with such a change, but a provisional figure to Load Control for Cargo calculations and the Refueller for provisional Ramp Fuel can be provided as shown.

VAU30/26 VPE LAX-SYD	
WEIGHTS	PLANNED
ZERO FUEL WT	**217315**
RAMP FUEL	123185
TAXI WT	340500
TAXI FUEL	500
TKOF WT	**340000**
DELTA BURN LNDG	**440**
TOW PS 1000	295

$$\Rightarrow \boldsymbol{\Delta\,ZFW = \frac{\Delta\,TOW}{(1 + DELTA\ BURN)}}$$

$$\Delta\,\mathrm{TOW} = 340.0 - 333.0 = 7.0\ \mathrm{Tons}$$

$$\Rightarrow \Delta\,\mathrm{ZFW} = \frac{7.0}{(1 + 0.440)} = \frac{7}{1.44}$$

$$= 4.86\ \mathrm{Tons}$$

$$\Rightarrow \quad \mathrm{ZFW} = 217.315 - 4.86$$

$$= 212.450\ \mathrm{Tons}$$

$$\Delta\,\mathrm{Trip\ Fuel} = \Delta\,\mathrm{ZFW} \times \mathrm{LNDG}$$

$$\Delta\,\mathrm{Trip\ Fuel} = -4.86 \times 440 = -2138\ \mathrm{Kg}$$

In the example given, the quick calculation yields a reduction in ZFW of 4860 Kg to 212.4 Tons to and a reduced Ramp of 2138 Kg to 121.1 Tons.

In comparison – a re-run of the flight plan results in a new ZFW of 212.8 and a Ramp Fuel of 120.7.

Again – final figures should be determined through an updated ACARS plan from Dispatch, and often figures can be read out over the SATCOM or VHF if desired to get an initial, definitive answer.

VAU30/26 VPE LAX-SYD	
WEIGHTS	PLANNED
ZERO FUEL WT	**212877**
RAMP FUEL	120623
TAXI WT	333500
TAXI FUEL	500
TKOF WT	**333000**

11.36. Checking the Preliminary Loadsheet

The Preliminary Load Sheet (PLS) is checked for accuracy and the ZFW provided is used as the basis of calculation of RAMP and TRIP fuel, and subsequently RAMP, TOW and LAW.

Checking the PLS comprises a flow across and through the document, calling certain values, partly to verbalise the validation process, partly to involve the First Officer in this cross check and to provide information to the First Officer for the CFP.

"Load sheet Edition One; Brisbane LAX, VA-7, 6th of June, Aircraft VPD. Crew 4 + 13, Pax 339, so POB 356.

Seatrow Trim used; Pantry Code L1, Potable Water correction made. No deductions.

There is NO NOTOC, Captain is Wayne.

So .. The ZFW is 208.3 – let's look at the Plan.

1. **Edition Number**
2. **Identification Lines**
   - Flight Num, Date, From, To, Aircraft, From, To, Aircraft Registration
3. **Crew Complement**
   - against Crew on Board; notify Load Control in advance if other than 4+13
4. **Passenger Number**
   - against maximum capacity 339
5. **Seatrow Trim**
   - identifies how the cabin was loaded – Seat Row vs Cabin Section
6. **Pantry Code** (L1 Oz ✈ US; L2 US ✈ Oz)
7. **Service Weight Additions**
   - **Potable Water**; Unless otherwise notified, there should always be a correction for reduced Potable Water.
8. **Service Weight Deductions**
9. **NOTOC**
   - Ensure NOTOC arrives if specified on the Prelim/Final Loadsheet
10. **Captain** - you worked for it, make sure they spelt your name right.
11. **Zero Fuel Weight**
    - to be used on the CFP for the Final Fuel weight calculations.

```
     13:20 [VA7]                PRELIM LOADSHEET
 1   VERSION:01
     LOADSHEET PRELIM 13:30
 2   VA007/06 06JUN17
     BNE LAX VH-VPD 4/13 3
11   ZFW 208300   MAX 237682 L
     TOF 110392
     TOW 318692   MAX 351534
     TIF 098135
     LAW 220557   MAX 251290
     UNDLD  29382
     PAX/37/24/278 TTL 339 4
     LIZFW          47.0
     LITOW          41.8
                FWD-LMT  ACTL   AFT-LMT .
     ZFWMAC    22.00   26.95  33.00   .
     TOMAC     22.00   27.50  33.00   .
     A37 B24 C92 D92 E94
 5   SEATROW TRIM
     SI PREPARED BY KENNETH 1150
     33749170834
     BW  166910
     BI  34.4
 6   PANTRY CODE  L1
     SERVICE WEIGHT ADJUSTMENT WEIGHT/INDEX
     ADD
 7   LAX POTABLE WATER
     1178   3.7
     DEDUCTIONS
 8   NIL

     LOAD IN CPTS 0/0 1/200 2/1100 3/1000
     4/1200 5/200
 9   NOTOC: NO
     CPT WAYNE 10
```

$$\frac{17+339}{=356}$$

Notes:

- If the PLS ZFW is different to the CFP – then Fuel Recalculation will be required, and **the PLS TOF, TOW, LDW values will be incorrect** – because they are based on the original CFP ZFW (despite being on the PLS with an updated ZFW).
- **Edition Numbers** (Load sheet and NOTOC) are occasionally passed onto Load Control to ensure you have the latest Edition.
- Ensure the various components of the Identification Line (2) are accurate.
- **Crew** should be verified against actual on board. Both Crew and Pax are transferred to the CFP and a calculation/crosscheck of POB completed. An alteration in crew should be notified to Load Control before requesting the PLS.
- **Underload** can be called for awareness.
- Once the load sheet check is complete, the next logical step is typically a cross check of TLDC's and commence Final FMC Performance data entry.
- DOW and DOI are not verified in this instance.

11.37. Preliminary Loadsheet Calculations

```
13:20 [VA7] PRELIM LOADSHEET
VERSON:01
LOADSHEET PRELIM 13:30
VA078/06 06JUN17
BNE LAX VH-VH-VPD 4/13
ZFW 208300  MAX 237682 L
TOF 110392
TOW 318692  MAX 351534
TIF 098135
LAW 220557  MAX 251290
UNDLD  29382
```

The Preliminary Loadsheet is typically available as soon as requested after Flight Crew arrive on the Aircraft. Once checked, it drives Refuelling, TLDC and other aspects of the operation, so requesting it straight away and getting onto the calculations promotes good task management and leads towards better OTP. While there's a host of numbers that need checking (see **Checking the Preliminary Loadsheet)**) – in the end it's the ZFW that will drive these calculations. By design, this ZFW should be the maximum likely for departure with subsequent reductions likely and increases possible …

Based on this (*not so final*) ZFW, the Ramp Fuel will be determined. The basis of these calculations include the Delta Burn and PS/MS values, extra fuel, etc and are detailed elsewhere (see **Use of Delta Burn, PS1000, MS1000 fuel correction figures**), but they are completed on the Flight Plan. The first stage (Preliminary Loadsheet) calculations are completed under the "REV" column. Nominally each crew member completes this column separately and then cross refers to verify calculation accuracy. When operating close to Max TOW, Performance Limit TOW and occasionally Max Landing Weight, cross reference is essential.

	EST	REV
ZFW	209300	208.3
FOB	111205	110.9
RW	320505	319.2
TAXI + APU	813	0.8
TOW	319692	318.4
FF	98135	97.8
LDW	221557	220.6
FOD		12.3
DELTA BURN/1000KG LDW		402

a) Enter the ZFW against the Planned ZFW.
b) Calculate/Decide the Change in FOB, FF and TAXI+APU.
c) Individually enter/calculate the column of figures.
d) Continue the calculation through to Fuel Over Destination (FOD) which is the result of (REV LDW – REV ZFW) = FOD. The Revised FOD can be compared to the Planned FOD. If they're very close, either your calculations are accurate, or you made at least two mistakes …
e) Cross refer with the other Pilot(s) for accuracy.
f) Transmit the final Ramp, Trip and Taxi Fuels to AMCO (VHF)
g) Provide the final Ramp fuel to the Refueller (Intercom)

	TIME	FUEL
FOD	02:01	12257

Note :

- While nominally step (b) is part of the independent cross check, some discussion with the other pilot over these three values can save considerable time when doing the final comparison of calculations. Ensure to avoid cross contamination when you confer.
- Ensure you check Structural and Performance limits of ZFW, RAMP, TOW and LDW – and beware of Mass/Volumetric limits of Fuel Capacity on very long flights.

11.38. Accepting the Final Loadsheet (FLS)

The FLS should arrive by ETD-15. This is the first time you're getting a (mostly) Final, and (mostly) Accurate numbers – ZFW and POB, anyway. Much of the following is similar to the PLS (see Checking the Preliminary Loadsheet)

1. **Edition Number**
2. **Identification Lines** (Flt Num, Date, Route, Aircraft)
3. **Crew Complement** (4+13)
4. **Passenger Number** (max 339)
5. **MACTOW** (Record on CFP, to be entered into FMC)
6. **NOTOC** (If there is one – has it come through?)
7. **Captain**
8. **Signature** (Don't forget to sign)
9. **TLDC Vref 30 Speed Crosscheck**
10. **ZFW** (10); **TOW** (11) and **LAW** (12) are written onto the CFP and crosschecked for changes against the values calculated from the PLS.

This acceptance procedure should be completed before you electronically ACCEPT the ACARS Loadsheet/NOTOC messages.

```
     13:35 [VA7]                   FINAL LOADSHEET
1    VERSION:01
     LOADSHEET FINAL 13:35
     VA007/06         06JUN17
2    BNE LAX VH-VH-VPD        4/13  3
10   ZFW 209300   MAX 237682 L
     TOF 110400
11   TOW 319700   MAX 351534
     TIF 098200
12   LAW 221500   MAX 251290
     UNDLD 28382
     PAX/37/24/278 TTL 339  4
     LIZFW   46.5
     LITOW   40.8
     MACZFW  27.2
5    MACTOW  27.5
     STAB TO .........
     A37 B24 C92 D92 E94
     SEATROW TRIM
     SI PREPARED BY KENNETH 1150

     NOTOC: NO
6    CPT WAYNE
                 7                    8
     SIGNATURE ....................

     TLDC GROSS ERROR CHECK  9
     CALCULATED VREF : 172
```

11.39. Transferring the FLS to the Flight Plan

As part of validating / accepting the FLS, the critical values are transferred to the Flight Plan.

In reality, only the ZFW, TOW and LAW should be critical. Remember that if the ZFW in the FLS varies from that in the PLS, a TLDC update may be warranted, and the previously calculated Trip Fuel may need updated.

```
13:35 [VA7] FINAL LOADSHEET
VERSION:01
LOADSHEET FINAL 13:35
VA007/06         06JUN17
BNE LAX VH-VH-VPD    4/13
ZFW 208000   MAX 237682 L
TOF 110400
TOW 318400   MAX 351534
TIF 098200
LAW 220200   MAX 251290
```

	EST	REV	ACTUAL	LIMIT WT	
ZFW	209300	208.3	208.0	MZFW	237682
FOB	111205	110.9		FCAP	143203
RW	320505	319.2		MRW	352441
TAXI + APU	813	0.8			
TOW	319692	318.4	318.1	MTOW	351534
FF	98135	97.8		RTOW	
LDW	221557	220.6	220.3	MLDW	251290
FOD		12.3			
DELTA BURN/1000KG LDW	402				

12. Pushback, Engine Start, Aircraft Taxi

12.1. "Can I close the Door Captain?"

This, along with "**Are you Ready for the Approach**" are two of the most loaded questions in the aircraft/simulator. The checklist of items that need to be satisfied prior to closing the doors is moderately long and un-published. It includes Load sheet, Fuel Record Form, Tech Log, Passenger Manifests, cargo doors, passenger signs, passenger address, slot times, and more. Beware of flippantly answering "**Yes**" to the FM when asked this question.

Note the checklist shown here is not a standard procedure and it's entirely likely you'll choose to close doors without having completed all the items listed here … but the point at which the doors are about to be closed is a good point to note that some of these are still to be done …

Before Doors Closed

- ✓ Panel Scans
- ✓ FMS (ZFW & FMC)
- ✓ Pre-Flight Checklist
- ✓ Briefings
- ✓ Takeoff Data
- ✓ Tech Log
- ✓ Fuelling Complete (Docket)
- ✓ Airways Clearance (PDC)
- ✓ Prelim/Final Load Sheets
- ✓ Cabin Signs
- ✓ Passengers Seated (PA)
- ✓ Cargo Doors ??

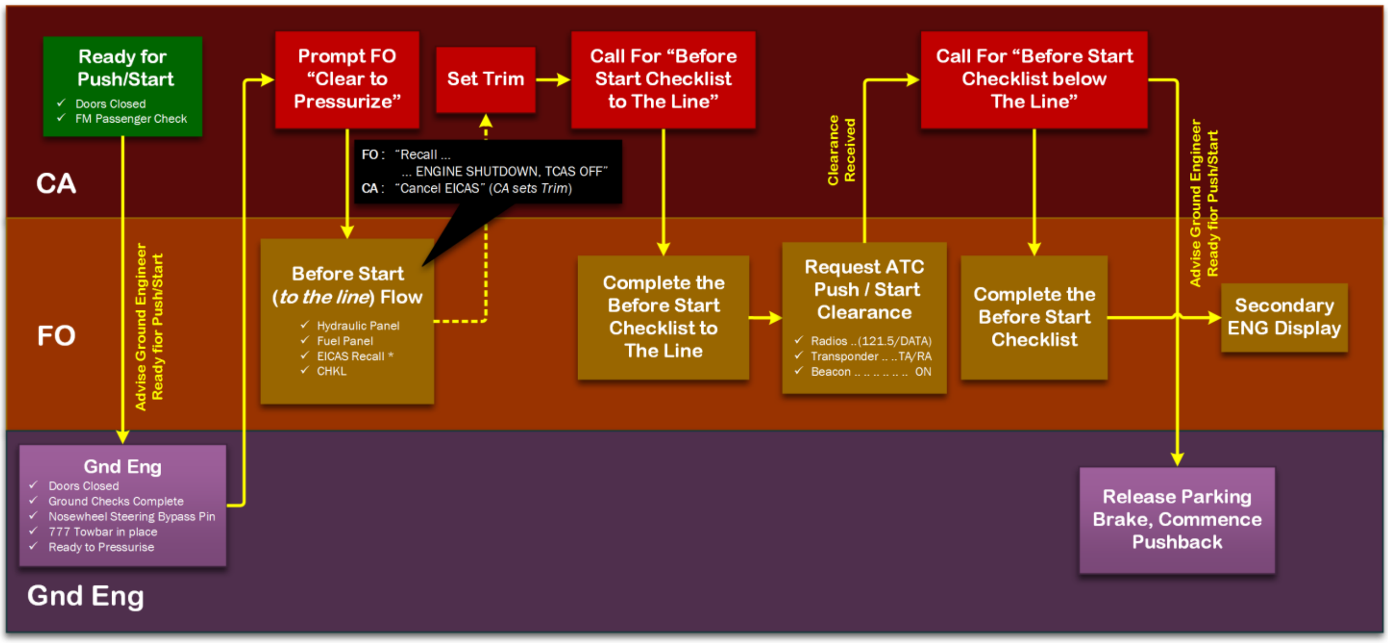
12.2. Pushback Sequence

The push and start sequence can be a little confusing until you've done it a few times. Starting at the green box …

- When the Captain believes the aircraft is ready for pushback, the Captain contacts the ground engineer to confirm readiness for engine start and pushback.
- Once received, the Captain advises the First Officer "**Cleared to Pressurize**".
- The First Officer commences the before start flow up to the EICAS Recall, which requires the Captain's input.
- Once the Captain has reviewed the EICAS and called "**Cancel EICAS**", the Captain will set the trim (*hydraulics are pressurised by this point*). Meanwhile the First Officer finishes the before start flow with the EFIS CHKL button to display the **Before Start Checklist**.
- This checklist is then actioned to the Line (*leaving out TCAS TA/RA and the Beacon*).
- The Captain will then ask the First Officer to obtain Push/Start Clearance from ATC. When clearance is received, the First Officer completes the rest of the before start flow (*Radios, Transponder, Beacon*) and the Captain will call for the "**Before Start Checklist below The Line.**"
- With the checklist complete the aircraft is fully ready for pushback, the Captain speaks to the ground engineer and start/push commences.

BEFORE START CHECKLIST

☐	Flight deck door	Closed and locked	F/O
☐	Passenger signs	AUTO, ON	C
☐	MCP .... V2 ___, HDG/TRK ___, ALT ___		C
☐	T/O speeds................ V1 ___, VR ___, V2 ___		C
☐	CDU pre-flight	Completed	C
☐	Fuel	___._ Tonnes	C
☐	Trim..	___ Units, 0, 0	BOTH
☐	Taxi and T/O briefing.....................	Completed	C
	--		
	Transponder..	TA/RA	F/O
	Beacon	ON	C



Note that the introduction of a line in the Before Start Checklist facilitates pressurisation of the hydraulics (and other pre-push/start activities) before calling ATC and is thought to expedite the departure process – it is not a Boeing approved procedure.

12.3. Before Start Checklist … To The Line

The introduction of "The Line" in the Before Start Checklist is a change in the usage paradigm of the Boeing ECL. The Before Start Checklist is broken into two "sections" and further critical items are actioned on the basis of the section being "complete" without the ECL annunciating this. Accordingly, the following is a suggested technique to action this checklist in line with Boeing ECL philosophy.

BEFORE START CHECKLIST		
Flight deck door	Closed and locked	F/O
Passenger signs	AUTO, ON	C
MCP	V2 ___, HDG/TRK ___, ALT ___	C
T/O speeds	V1 ___, VR ___, V2 ___	C
CDU pre-flight	Completed	C
Fuel	___._ Tonnes	C
Trim	___ Units, 0, 0	BOTH
Taxi and T/O briefing	Completed	C

- The Captain initiates the **Before Start Flow** by calling "**Cleared to Pressurize**".
- The First Officer completes the Before Start Flow with the EFIS Control Panel CHKL button, displaying the **Before Start Checklist**.
- The Captain calls for the "**Before Start Checklist to The Line**".
- The crew complete the checklist down to '**Taxi and T/O briefing … Completed**' – at which point the First Officer advises "**Before Start Checklist to The Line**".
- The checklist is <u>not complete</u> at this point; hence there is no check by the ECL logic that the first section of the checklist contains no outstanding items (*closed loop or otherwise*). As such, it's important that both crew must verify (*silently*) that all items above the line are closed with the "**Before Start Checklist to The Line**" call from the First Officer.
- The ECL should remain displayed at this point on the completed "first section" of the **Before Start Checklist**. The "below the line" section should not be peremptorily displayed until the relevant flow is complete.
- After Push/Start Clearance; Transponder and Beacon items are actioned by the First Officer; the First Officer completes this flow with either the CHKL button (twice) or the **[Page] "2"** prompt to display the rest of the Before Start Checklist.
- The Captain calls for the "**Before Start Checklist below The Line**" and the crew complete the checklist.

BEFORE START CHECKLIST		

Transponder	TA/RA	F/O
Beacon	ON	C

12.4. Start During Push Back

There is no limitation in starting either or both engines (*one after the other*) during pushback. There is also no technical reason for starting one engine in preference to the other. A minor consideration is perhaps starting the engine that is inside the turning pushback to minimise stress on the towbar, but this is not considered limiting.

Start during push is considered normal practice and is to be encouraged as normal operation during training. Note however that there may well be local limitations associated with parking position, or a limitation associated with a non-777 rated tow bar that may preclude engine start during push back.

12.5. Engine Number One or Left Engine

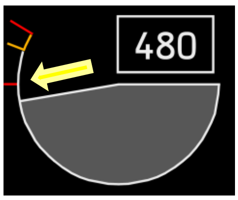
By convention, all internal flight deck communications refer to the engines as Left or Right. External communications, such as with the ground engineer, should use "**Number One**" (Left) or "**Number Two**" (Right) terminology.

12.6. Fuel Control Switch to RUN During Start

The Fuel Control Switch can be moved to RUN during the engine start as soon as the First Officer has moved the Engine START/IGNITION selector to START. There is no requirement to wait for Oil Pressure, engine rotation or oil temperature.

12.7. Starting engines quietly

There are two normal engine start calls. They are "**Start Left**" (Engine) and "**Oil Pressure**". Calls during Autostart such as "Fuel On", "Rotation", "Light Off", "Starter Cutout", "Roll Back", "Stable" and more are superfluous and not required (*nor in accordance with SOP*). Engines Stable after start and the subsequent First Officer flow is assessed through the removal of the EGT Start Limit Indication on the EICAS after engine start.



12.8. Start Abnormalities and the Outside World

During start abnormal, try to resist the tendency to lose the outside world. There are probably people out there who would love to hear that you have a hot/hung start and plan on blocking the taxi way and keeping the ground engineer from his coffee for at least another 2-3 minutes, perhaps more. Share and enjoy.

12.9. Clear to disconnect after Recall

The engineer should not be cleared to disconnect headset from the aircraft until after the "**Recall**" during the after start flow has been acknowledged and cancelled "**Cancel EICAS**" (*or* "**Check**" *in the case of no EICAS messages*) by the Captain – and the aircraft has come to a halt with the **Parking Brake … Set**. The function of the EICAS Recall at this point is for the Captain to be satisfied that after start the aircraft is fully serviceable to Dispatch for the flight.

12.10. Engine Anti-Ice ON after start

The FCOM SP specifies that the EAI is turned ON when required immediately after both engines have been started. In the event of an engine start sequence disruption where the first engine will remain running for some time prior to the second engine start, Training/Standards recommended technique is to select EAI ON when required after each engine start. This protects the running engine against icing conditions. The Boeing FCOM defines icing conditions to be a combination of outside air temperature at or below 10° combined with low visibility (1600m / 1sm) and/or precipitation on the plane, ramp, taxi-ways or runway.

12.11. Guarding Fuel Control Switches

AUTOSTART handles almost all start abnormalities that are likely to require intervention on the 777. Traditionally the Captain would be expected to guard the Fuel Control Switches during engine start in order to prevent a Hot Start. This is not considered to be a requirement during engine start on the 777.

While there is the remote possibility of a Hot Start (*combined with an Autostart system failure*) during which the Captain might have to intervene – training has historically shown that the more likely result of hands on the fuel control switch during start is inappropriate intervention in a start that's being managed quite well by Autostart.

Autostart corrects for:
- no EGT rise
- a hot start
- a hung start
- no N1 rotation
- a compressor stall
- a starter shaft failure
- insufficient starter air pressure
- a start time that exceeds the maximum starter duty cycle time

Do the ABORTED ENGINE START checklist for the following abort start condition:
- there is no oil pressure indication after the EGT increases

As such Training/Standards recommends that Captains do not keep their hands on the Fuel Control Switches during start. Rest them on the Thrust Levers instead, while monitoring engine start progression.

12.12. Weather Radar ON during Taxi

SOPs specify that the weather radar should go on during taxi after the Cabin Ready and the Departure Review have been completed. That said, if the aircraft is taxiing such that a 20/40 mile weather radar display would give a preview of the weather on departure – WXR should be selected on for this purpose, and can be selected off if necessary once that appreciation is gained. Or not.

12.13. When to run the Before Takeoff Checklist

Once taxi commences, PF will wait until the aircraft is in a clear area and the mental demand of taxi is low (*straight line, wide taxi way, etc*) and if an airways clearance has been received and briefed, will call for the Departure Review. Upon completion of the Review, PM will display the Before Takeoff Checklist. The checklist can be run when (a) Cabin Ready has been received; (b) the Departure Review is complete; and ideally (c) Weather Radar/Terrain selections have been made.

12.14. Carbon Brakes – Operating Differences

There are operating differences between the 777's Carbon Brakes and the steel brakes found on older aircraft. The primary operating difference stems from the wear nature of the material. The two significant factors affecting carbon brake wear are the physical number of applications (*rather than the length or strength of application*) and the temperature of the material during the application of braking. Within reason the fewer the brake applications and the warmer carbon brakes are during multiple braking applications, the less the brake wear.

Operationally this means that brake wear is reduced by a small number of long, moderately firm brake applications instead of numerous light applications. Hence the technique of allowing speed to build up during taxi (*appropriate to the taxi environment*) and a single continuous brake application to reduce speed significantly before allowing taxi speed to increase again.

The use of Autobrake 1 for landing can increase carbon brake wear when the intent is a roll through on the runway. This is because the combination at Autobrake 1 and Reverse Thrust can result in the cycling of the brakes to maintain the low rate of deceleration commanded.

12.15. Returning to Stand

Whether due technical, operational or a passenger issue, returning to stand is not a manoeuvre supported directly by the SOPs. Usually the key to covering yourself for a return to stand situation is to assume you've just cleared the runway after landing and commence the appropriate flow (easiest to initiate by calling for the After Landing Checklist). Don't forget to consider communications as part of the decision/implementation of a return to stand. ATC, Cabin, Company, etc.

12.16. Departure Review – Read the Glass!

The Departure Review is strictly a glass reading exercise. The only instruments that should be referred to are the two CDU's and the ND/PFD. Do not read the V2, Selected Altitude/Heading from the MCP without a positive crosscheck of the glass (PFD/ND) – see **Read the Glass!**

12.17. Departure Review – What Track/Heading Do I Set?

The **Departure Review** is called for by the PF and actioned by the PM somewhere between the completion of the **Before Taxi Checklist** and the **Before Takeoff Checklist**.

While generally performed when clear of congested areas during aircraft taxi in a straight line and therefore the cognitive demands on the PF/PM are lower – it can be done stationary after pushback if the opportunity presents. On completion the EFIS **CHKL** switch is pressed to display the **Before Takeoff Checklist**, so it's not forgotten.

Review Component	PM Statement	Check
Flap	*" Flap ___ "*	CDU-L TKOFF REF Required Flap against Flap Lever & EICAS indicated Flap. *Check CDU against Flap Lever and EICAS Flap Indication.*
Runway	*" Runway ___ "*	CDU-L TKOFF REF Selected Runway (and intersection) vs ND Runway indication. *Check against Pilot selected Runway (your current taxi destination).*
Speeds	*" V1 ___ "*	Required (CDU-L TKOFF REF V1) against PFD displayed V1.
	" V2 ___ "	Required (CDU-L TKOFF REF V2) against MCP Selected Speed (read from PFD). *If an OFP or OPT V1/V2 is immediately available, a cross-check is also advised.*
FMA	*" TOGA TOGA, (LNAV) (VNAV) Armed "*	**Flight Mode Annunciator** – Engaged and Armed modes. *Mentally confirm these are the armed modes you require against your Clearance.*
Selected Altitude	*" ____ Set "*	Call the MCP Selected Altitude (read from the PFD). *Confirm against the ATC Clearance / first **At-or-Not-Above** SID altitude restriction.*
Hdg/Trk Bug	*" Heading/Track ___ "*	PFD Selected Heading/Track. *Compare Heading/Track with Runway. Consider ATC Departure Instruction/EOP.*
Departure	*" Departure ___ "*	Read the SID identifier from CDU-R RTE P2 page. *Ensure the SID is as briefed during pre-flight.*
Checklist; Takeoff Review Complete	Press CHKL button on the EFIS Control Panel	Display the **Before Takeoff Checklist**. The takeoff review then completes with the standard call "*Takeoff Review Complete.*"

There has been some discussion about what heading or track should be set for takeoff. The answer is – whatever the PF wants.

Ideally there should be some logic to this selection. For example … at one point the KLAX PERCH 9 departure required the aircraft to maintain heading 250° after departure (*not runway heading*) …

- KLAX/RW25R/Perch 9 Departure – MCP Heading Set 250°; because HDG SEL will be engaged at 400 ft.
- KLAX/RW25R/Perch 9 Departure – MCP Heading set 249°; because that's the runway QDM (this week).
- KLAX/RW25R/Perch 9 Departure – MCP Track Set 251°; because if an engine fails, TRK SEL will be engaged at 400 ft.

You could argue that statistically there's a higher chance of needing Heading 250 after takeoff (*in this case something like 99.99%*) and therefore pre-setting Heading 250° is logical.

You could argue that pre-setting Heading 249° complies with the SOP NP Departure Review "*Compare Heading/Track with Runway. Consider ATC Departure Instruction/EOP.*"

You could argue that in the event of an engine failure, the safety requirement to be able to reach up and engage TRK SEL 251° without having to fiddle with MCP selections overrides other considerations – especially since the Perch 9 can be flown in LNAV anyway.

You could argue all of these things and I wouldn't argue against you; if you've put that much thought into it – you deserve to have the Heading/Track bug where you want it for takeoff.

Note : The text on HDG/TRK Bug in the SOP NP Departure Review was never meant to imply that the heading/track bug must be aligned exactly with the runway. Just that instructors in the sim get tired of hearing (*after a rushed pre-flight setup*) "**Departure Review … Flap 15 … Runway 16 … Heading 340 … for a BISON ONE …** " etc. It's soul destroying.

12.18. Runway Change On Departure

A crew make dozens of entries, selections and decisions during pre-flight that are tied to a specific runway and the departure direction associated. In addition, a complex mental model which includes terrain, weather, NOTAMS, procedural implications and more is established by briefing and other thought developing processes. All of these are typically accomplished through practiced, familiar processes that happen in and out of sequence and are the result of learned, practiced behaviours.

Hence a runway change – especially once the aircraft has begun to taxi – is a significant disruption to many aspects of safe flight. After a runway change, dozens of changes are often required to ready the aircraft for Takeoff, including changes to the aircraft setup:

- Airways Clearance and ATIS
- Take off performance calculation
- Aircraft Configuration (Flaps, Thrust, Trim)
- FMC (Runway, SID, Takeoff Performance)
- MCP (Modes, Heading, Altitude)
- Engine Out Procedure (Fix page, FMC EOAA)
- Departure Briefing

While most of these changes are mechanical in nature and can be the result of a checklist – such as the Runway/Clearance/Performance Change Procedure shown here – more complex is the development of a pilot's mental model of the taxi, takeoff and flight departure. This can generally only be achieved – particularly across the flight deck – by repeating/updating the Departure Briefing once the changes have been determined, evaluated and implemented in the flight deck.

Runway/Clearance/Performance Change	
ATIS & **ATC Clearance**	Obtained
NOTAMS / **Jepp 10-7** – Consider new runway	Checked
Takeoff Performance (TLDC) - Update Takeoff Solution as required for Runway / ATIS	Completed
FMC Change : Implement as required - **DEP ARR** : New Runway/SID (check RTE page 2) - **LEGS** : Review SID legs/speeds/altitudes - **FIX** : MSA/LSALT/EOP as required - **NAV RAD** : Aids for new SID as required	Checked
FMC Performance Entry - Repeat complete sequence using laptop/load sheet from **ZFW** to **CDU VNAV Alt/Fuel** check - **MCP** : V2, Initial Heading/Track; Selected Altitude	Complete
Stab Trim as required by the FMC	Set
Flap Selection (as per TLDC)	Selected
Other : Consider **DDG**; **Packs Off**/**APU to Pack**; etc	Checked
Departure Brief : Update as required - **Non Normal** (EOP); and - **Normal Brief** (Taxi, Runway, SID and Takeoff performance)	Complete
Repeat **Normal Checklists / Procedures** - **Departure Review** Procedure - **Before Takeoff Checklist**	Checklist Complete

Often the first indication of a previously unknown runway change is the direction of pushback in the push/start clearance. In this case the most appropriate response is usually to cancel push/start, remain on stand and action the change. While this can result in a departure delay, it results in a better change action with less time pressure on the crew to accomplish what needs to be done.

Supplementary Procedures
Runway/Clearance/Performance Change

Once the aircraft has begun to move, the recommended response to a runway change is to find an appropriate place for the aircraft to stop so all crew can be involved in the procedure. While relief crew can perform some useful preparation for a runway change during taxi, PF and PM should be fully engaged in ensuring safe taxi of the aircraft, rather than actioning a runway change procedure while the aircraft is moving.

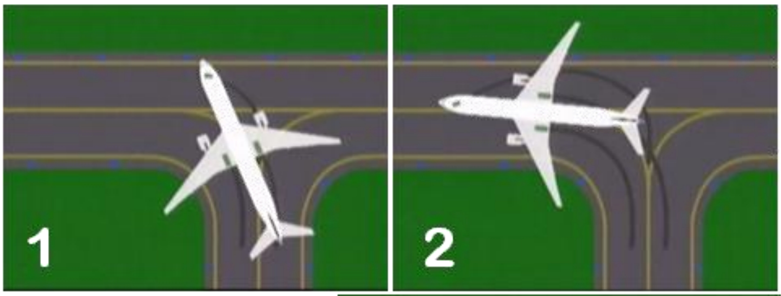
The **Final FMC Performance Entry** procedure must be actioned in full no matter how small the changes involved in takeoff performance – from ZFW verification through to MCP and VNAV Climb Page Altitude/Fuel Checks. Once the Departure Briefing is updated the **Departure Review** and **Before Takeoff Checklist** must be completed (*or repeated if necessary*).

Note the Runway/Performance/Clearance Change Checklist should be actioned after any runway change subsequent to completion of the Final FMC Performance Entry Procedure. The Runway/Clearance/Performance Change Checklist/Procedure is available in the FCOM SPs and the ECL. Note that this procedure can be actioned as a "Done List" (like Normal ECL) or a "Do List" (like NNM ECL).

12.19. Taxi Technique – General Tips

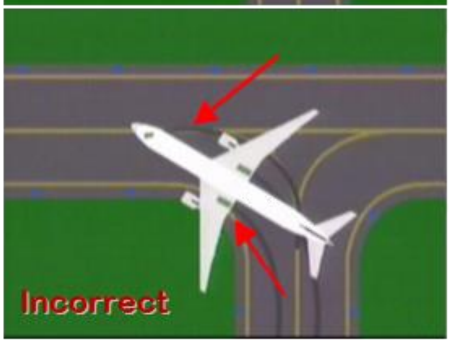
The FCTM contains fairly comprehensive guidance on taxiing the aircraft in a variety of conditions. Issues such as flight deck perspective and visual cues, taxi speeds, oversteering, thrust and rudder/tiller usages are essential reading for safely, efficiently operating the B777 aircraft on the ground. The following tips directly address taxi deficiencies that have been observed during line operations.

- Turns of near 90° or more should be entered at no more than 10 knots (less if the ground surface is slippery). This significantly reduces the centrifugal effects on passengers at the rear, as well as the likelihood of the tyre scrubbing associated with turns on painted surfaces (wet or dry).
- Typically, outside engine thrust application will be required during turns of 90° or more on dry surfaces at heavy weight to keep taxi speed up near 10 knots. As with all tactical thrust usage on the ground, application should be anticipated and the area behind the aircraft verified clear of frangible items. Be particularly aware when turning through 90° with light objects such as empty ULD’s on the Apron or beside Taxi-ways.

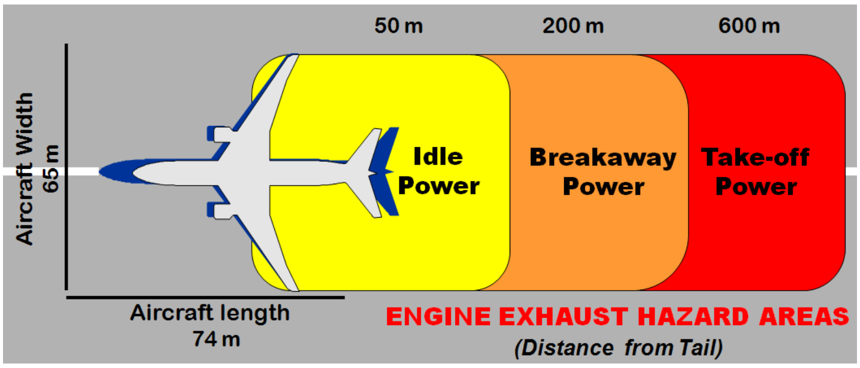


- Oversteering is a requirement on narrow taxi ways and should be regularly practiced on wider ones. The visual cues described in the FCTM work and should be practiced to increase confidence in them for the day when they are required on particularly narrow taxiways (*New York, here we come*).
- On particularly narrow taxi-ways, the PF may have to parallel the nosewheel along the edge of the taxiway after the initial turn until the mains have come clear of the edge prior to returning to centreline.

- The Tiller must be used with a good grip and smooth inputs applied to avoid the “jerking” that can be felt down the length of the aircraft when the tiller is not used smoothly. This is particularly so when releasing the pressure on a tiller coming out of a turn.
- Since its introduction on the 777, Main Geer Steering Takeoff Configuration Warnings during takeoff thrust application (too) shortly after turning onto the runway have been an occasional accompaniment to those new to the aircraft. Main gear steering operates when the nose wheel steering input is more than 13° and speed is less than 20 knots, which pretty well describes the parameters of every runway entry for takeoff. Ensure a few seconds are left to allow the main gear to straighten before applying takeoff thrust.



12.20. Thrust Usage on the Ground



The thrust produced by the 777-300 engines at idle is considerable – at most weights the breakaway thrust requirement is not much more than idle.

As such it is crucial for the Crew to maintain situational awareness of what is behind the aircraft anytime thrust is increased above idle while taxiing.

Thrust increases are often required for:

- Taxi commencement at very heavy operating weights.
- Turns of 90° or more, particularly on narrow taxi ways where turns are conducted with appropriate FCTM judgemental oversteering.
- Up slope taxiways – particularly associated with turns.

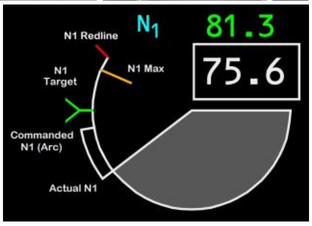
Thrust increase should generally be anticipated – that is, thrust applied just before it's required. In concert with this anticipation, the area that will be behind the aircraft when thrust is to be increased should be considered by the flight crew. Damaging ground equipment and personnel is well within the capabilities of the thrust output of the 777 engine during normal taxi operations. Single Engine Taxi operations particularly require awareness and anticipation.

12.21. TAT, OAT and Assumed Temperature



There is an inherent relationship between Outside Air Temperature (OAT), Total Air Temperature (TAT) and Takeoff Performance Calculation Thrust Assumed Temperature (ASS?)

- TAT/OAT is sensed/calculated by the Aircraft TAT probe and displayed on EICAS.
- TAT is also sensed by each Engine's TAT probe.
- There's a system cross check between these two sources of temperature. In the event of a deviation between Aircraft and Engine TAT (>2.5°) the onside EEC will bias it's calculation towards the Engine TAT probe until the difference is significant (>5°) at which point – Engine TAT probe wins. The EECs use this temperature for N1 Max, Commanded N1 and Actual N1 display on the EICAS.
- In EEC Hard Alternate Mode – it's all about the Aircraft with the N1 Max being calculated by the FMC using Aircraft TAT.
- The FMC monitors OAT/TAT against the Assumed Temperature selection, and gets upset if OAT/TAT exceeds the Assumed entry.



What does this matter? Well – if you're in the situation where the OAT/TAT (*indicated or actual*) is at or higher than your THR LIM Assumed Temperature value, it matters a lot. Particularly if the Aircraft OAT is affected by a falsely high reading (*as it sometimes seems to be during pre-flight when there's poor airflow through the probe*).

Common indications of this include:

- FMC scratchpad message **V SPEEDS UNAVAILBLE** "*For certain high thrust/low gross weight takeoff conditions, FMC VSPEEDS are not calculated. Adjust gross weight and/or takeoff thrust limit to enable VSPEEDs.*"
- FMC THRUST LIM page blanks with no selections/values
- Eventually … CDU scratchpad **TAKEOFF SPEEDS DELETED** with speeds dropped from the FMC and PFD.
- Things tend to return to normal when airflow through the TAT probe is restored - returning TAT to a more OAT-approximate value.

All of this tends to kick in after engine start. For more detail and the story behind it – see here.

13. Takeoff

13.1. HDG/TRK Select (and HOLD) for takeoff

While Heading/Track Select will engage on the ground and might even seem like a good idea when ATC want runway heading or a turn straight after takeoff, the practice is discouraged for the following reasons.

- If the mode is commanding a turn, the turn will commence very shortly after takeoff – irrespective of an engine failure that may occur and any subsequent engine out procedure that may apply.
- If HDG/TRK Select is engaged other than when the aircraft is lined up on the runway, when the aircraft gets airborne, the HDG/TRK Select logic may command a turn in the shortest direction based on which way the aircraft was pointing on the ground when HDG/TRK Select was engaged.

As such the use of Heading Select – and Heading Hold – prior to takeoff is not encouraged. Instead, call for a lateral mode at "**400**" ft when prompted by the PM.

13.2. FMC Climb Direct Feature on the ground

The FMC climb direct feature (CDU VNAV CLB page) actions with a single button push (followed by execution) the deletion of all legs page altitude constraints between the current aircraft attitude and the MCP selected altitude, or FMC Cruise Altitude, whichever is lower.

Usually each individual LEGS page speed/altitude constraint can be deleted with a single push of the MCP Altitude Selector without a need for Confirm/Execute … except on the ground where the MCP Altitude Selector knob push feature is disabled. In this situation, the FMC Climb Direct feature still works as described.

13.3. Main Gear Steering and Thrust Application

Main gear steering engages when the Captain's tiller is beyond approximately 13° and remains engaged until the Captain's tiller has returned to approximately 9° - after this point main gear locking takes approximately 5 seconds. Anytime a thrust lever is advanced beyond 60% N1 with the main gear steering unlocked, a **CONFIG GEAR STEERING** alert message is generated on EICAS. Note that rudder pedal steering alone generates up to 7° of steering and will not unlock main gear steering.

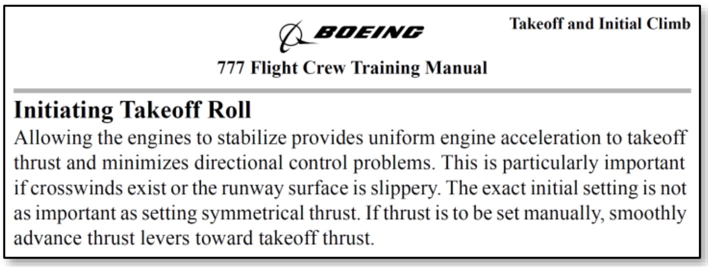
As crew become more confident with the aircraft, the occasional takeoff configuration warning is generated during thrust application on takeoff, when the main gear steering hasn't been given sufficient time to align and lock. This is generally best avoided – don't rush into TOGA when a sharp turn has been required during line up.

13.4. Takeoff – wait for 55%

Boeing specify thrust stabilisation at around 55% during thrust advancement for takeoff prior to TOGA switch activation. Two common errors associated with this are:

a) Pressing the TOGA switch too early, thus exposing the aircraft to the risk of asymmetric thrust application at very low (below V_{MCG}) airspeeds; and

b) Pausing too long trying to accurately achieve 55% prior to TOGA, using valuable runway in the process.


BOEING — Takeoff and Initial Climb
777 Flight Crew Training Manual

Initiating Takeoff Roll

Allowing the engines to stabilize provides uniform engine acceleration to takeoff thrust and minimizes directional control problems. This is particularly important if crosswinds exist or the runway surface is slippery. The exact initial setting is not as important as setting symmetrical thrust. If thrust is to be set manually, smoothly advance thrust levers toward takeoff thrust.

13.5. "Takeoff" … Then TOGA Switch

The "**Takeoff**" call from the PF is a decision/statement of intent call. Essentially it formalises the age old : PF : "**You Ready?**" … PM : "**Yup**" that pilots have been saying at each other as the aircraft straightens up on the runway and the crew commence the roll. It's the last chance for one of the pilots (*typically the PM if the PF has announced intent*) to halt the takeoff – whether for lack of clearance, blocked runway or some other reason.

For this reason, the "**Takeoff**" call should take place well before TOGA switch activation. Abandoning a takeoff roll commenced in error is a far simpler proposition if actioned prior to Autothrottle engagement. This is why the SOPs script the "**Takeoff**" … "**Check**" sequence prior to TOGA Switch Activation.

13.6. Eighty knots, Check, Hold, Check

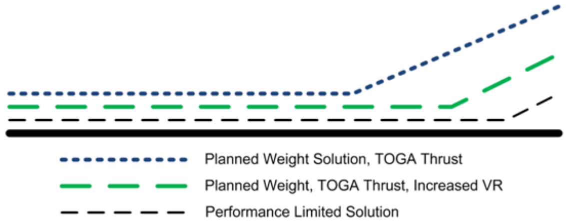
Normally this would be the correct response to an airspeed awareness call from the PM, and an FMA change called by the PF. However, Take Off is an SOP scripted event. The correct calls are documented. During takeoff when PM sees 80 knots IAS, PM calls "**Eighty knots**". PF looks down and cross checks the ASI, then looks up at the FMA, sees the Thrust mode change and calls "**Hold**". PM does not acknowledge this last call.

13.7. Increasing VR for Strong Crosswind Conditions / Windshear

The Boeing FCOM/FCTM advises using TOGA Thrust and a higher VR during strong and / or gusting crosswinds. Increased rotation speed provides increased tail clearance and stall speed margin.

To increase tail clearance during strong crosswind conditions, consider using a higher VR if takeoff performance permits. This can be done by:

- using improved climb takeoff performance methods
- increasing VR speed to the performance limited gross weight rotation speed, not to exceed actual gross weight VR + 20 knots. Set V speeds for the actual gross weight. Rotate at the adjusted (higher) rotation speed. This increased rotation speed results in an increased stall margin, and meets takeoff performance requirements.



Improved Climb

The FCTM also recommends the use of "Improved Climb". Improved Climb is essentially the increase of V2 (*and by association possibly VR and V1 as well*) to gain better second segment climb performance. TLDC uses improved climb on a tactical basis as and when required to maximise takeoff performance. There is no ability for Crew to turn on Improved Climb if it's not already in use; or increase the degree of use of Improved Climb if it is being used.

Increasing VR

The concept of increasing VR for strong/gusting crosswinds and/or potential windshear is based on the extra thrust available when the takeoff is at less than the performance limited takeoff weight **and full TOGA Thrust is used.**

To provide the data, two takeoff performance solutions are generated – one for the actual weight, one for the performance limited weight (*or structural limit if less*). This second solution provides the performance limited VR, which is not to exceed the actual weight VR plus 20 knots.

Speeds are set for the actual weight solution (*not the increased VR*). Rotation is delayed until the performance limited VR (*not to exceed actual weight VR plus 20 knots*). Once airborne the takeoff is continued normally, rotating to the all engine climb attitude until the flight director gives correct guidance. The additional speed carried into the air will be corrected by the Flight Director (*mostly*).

The Boeing FCTM offers specific suggestions when using this technique during gusts and/or crosswinds which should be reviewed as part of the Departure Briefing. By implication, the use of TOGA thrust as a response to strong crosswind conditions is a mandatory requirement of this technique.

Windshear

The FCOM SP for Adverse Weather recommends a similar technique when a takeoff is undertaken in potential windshear conditions. The calculations involved and settings are as above, the differences occur in the event of a windshear encounter during the takeoff.

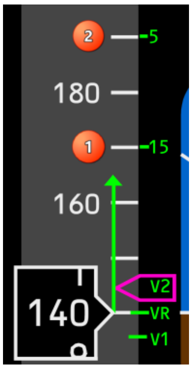
Consider increasing Vr speed to the performance limited gross weight rotation speed, not to exceed actual gross weight Vr+20 knots. Set V speeds for the actual gross weight. Rotate at the adjusted (higher) rotation speed. This increased rotation speed results in an increased stall margin, and meets takeoff performance requirements. If windshear is encountered at or beyond the actual gross weight Vr, do not attempt to accelerate to the increased Vr, but rotate without hesitation.

If windshear is encountered rotation **must not be delayed** until the increased VR, but commenced at the actual weight calculation rotation speed (*or 2000 ft before the end of the runway*).

13.8. Flap Retraction

During takeoff, don't delay flap retraction – call for the next stage of flap at the appropriate speed as advised in the Boeing FCTM. Delayed flap retraction at very heavy weights can hamper aircraft acceleration towards clean speed and result in unnecessary pitching moments as the next flap limit speed is approached during acceleration. Note that retraction takes place from F20/F15 → F5 → F1 → Flaps Up. Whether using Flap 20 or Flap 15 on takeoff – retract to Flap 5 once the acceleration has commenced and the speed adequate.

Takeoff Flaps	At "Display"	Flap Transition Speed	Select Flaps
20 or 15	"20" or "15" "5" "1"	Vref 30 + 20 Vref 30 + 40 Vref 30 + 60	5 1 UP
5	"5" "1"	Vref 30 + 40 Vref 30 + 60	1 UP



When in doubt, the PFD Airspeed Flap Speed indications shows you two flap settings. Your (1) Current Flap Setting; and higher up the speed tape is (2) the Next Flap Setting.

Flap Retraction Schedule
With airspeed increasing, flap retractions should be initiated when airspeed reaches the maneuver speed for the existing flap position. The maneuver speed for the existing flap position is indicated by the numbered flap maneuver speed bugs on the airspeed display.

Note that to initiate Flap Retraction, you need to see a speed increase trend – but not the PFD Speed Trend arrow.

13.9. Crosswind Takeoff – Aileron Deflection

It's been noticed that some crew aren't introducing sufficient aileron deflection during crosswind take-off's in order to maintain wings level during the takeoff roll – as evidenced by the notable increase in aileron deflection during the rotation to keep the wings level.

Part of this reluctance may be based on the FCTM's admonishment to avoid excessive aileron deflection during takeoff that could well result in spoiler deployment.

While the aileron deflection required to generate significant spoiler deployment is in excess of four units of aileron - the number is not the point. It's extremely rare to see aileron deflection of this magnitude – and somewhat more common to see insufficient aileron on our crosswind take-offs.

A good crosswind takeoff commences with zero aileron deflection, increasing aileron input in order to maintain wings level as the aircraft accelerates. With a strong wind from the right, you'll need right aileron – and a little left rudder towards the end as the crosswind impinges on the tail and weather cocks the aircraft out of wind.

If you've got it right – the aileron deflection you have at the end of the takeoff roll will carry you through the rotation and airborne – at which point, clear of the ground, you'll naturally correct the sideslip (*out of right aileron and left rudder*) to climb away in trim. Practice this in the sim and ask for the Instructor critique this aspect of your takeoff particularly to develop a good technique to carry into the aircraft.

13.10. Takeoff Rotation Rate

According to the Boeing FCTM, Takeoff Rotation should be a smooth continuous rotation of 2 to 2½ degrees per second towards 15° of pitch reference. Additionally, the attitude indicator is the primary pitch reference.

The first thing to note here is that rotation should be smooth and continuous – the aircraft has a tendency to slow it's pitch rate at about 10° of pitch (*as the mains think about leaving the ground*) – rotation must continue through this point and the rotation should not be allowed to stagnate. Note also that Boeing recommends a **consistent rotation technique** and **approximately equal control forces**.

The second point worthy of note is that rotation should take place **towards 15°**. The actual pitch attitude the aircraft stabilises at will be the result of a complex calculation of weight, thrust, centre of gravity, etc.

When your rotation technique is correct, you will notice two things – firstly you are pointed at the same place as the flight directors once your rotation is complete (*note this is **not** an invocation to use the flight directors during rotation*); secondly your airspeed will be very close to that written at the top of the CDU VNAV CLB page – V_2+25 knots.

BOEING — Takeoff and Initial Climb

777 Flight Crew Training Manual

Rotation and Liftoff - All Engines

For optimum takeoff and initial climb performance, initiate a smooth continuous rotation at VR toward 15° of pitch attitude. However, takeoffs at low thrust setting (low excess energy) will result in a lower initial pitch attitude target to achieve the desired climb speed.

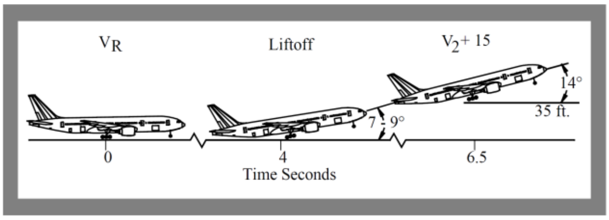
Note: The flight director pitch command is not used for rotation.

With a consistent rotation technique, where the pilot uses approximately equal control forces and similar visual cues, the resultant rotation rate differs slightly depending upon airplane body length.

Using the technique above, resultant rotation rates vary from 2° to 2.5° per second with rates being lowest on longer airplanes. Liftoff attitude is achieved in approximately 4 seconds.

Typical Rotation, All Engines

The following figure shows typical rotation with all engines operating.



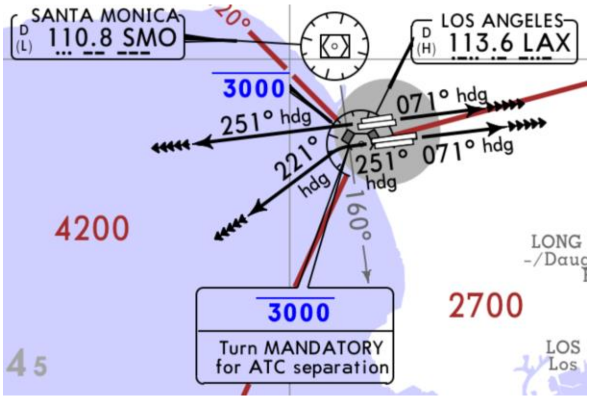
13.11. When to Rotate?

Takeoff Rotation is commenced as per the FCTM "*For optimum takeoff and initial climb performance, initiate a smooth continuous rotation **at VR** towards a 15° of pitch attitude.*" The requirement for the PF to initiate takeoff rotation **at VR** rather than in response to the PM call of "**Rotate**" has some implications for takeoff.

The PF should therefore have airspeed in the scan during takeoff, such that rotation is initiated at VR – not in reaction to the PM call. It's a small difference but can have an impact on an already critical takeoff such as heavy/hot departure from Abu Dhabi.

The technique of PM calling "**Rotate**" a little early during take-off's where tyre speeds are more critical (*eg: Abu Dhabi Hot/Heavy*) is not recommend by Training/Standards.

13.12. VNAV PTH after Take Off?



When operating from Runway 24/25 at LAX, departing on the PERCH or the LAXX6 (*and several other SIDS*), VNAV may change from **VNAV SPD** to **VNAV PTH** after takeoff, seemingly refusing to accelerate above 1000/3000 AAL. This is often perceived as a failure of the VNAV mode and a reversion to basic modes (*Flight Level change*) is suggested by the PF/PM/Sim Instructor.

While it's crucial for crew to learn to detect unusual behaviour in the AFDS and react accordingly where appropriate with a reversion to a more basic level of automation, it's also good value to understand the what and why of AFDS anomalies. In this instance, VNAV has reacted correctly to its programming.

While VNAV climbs are essentially a fixed thrust/selected speed based calculation (*see below*), in this case VNAV has decided the SMO R160R / 3000B climb restriction is at risk, and has engaged in **VNAV PTH** in order to meet that restriction. Acceleration will occur once the restriction has been met. This situation can be exacerbated by the excess thrust available at lower weights, and the use of 3000 ft AAL for noise abatement.

There is a fundamental difference in the design of VNAV between climbs and descent – at least between climb after takeoff to cruise altitude and descent from cruise altitude to the approach. The difference is VNAV PTH. Essentially a typical VNAV Climb is thrust/selected speed. The auto throttle is commanded to limit thrust (CLB, CLB1, CLB2, etc) and VNAV commands the elevators to maintain an airspeed (hence FMA **VNAV SPD**). The rate of climb (*and therefore the vertical path in space*) is continuously updated and re-calculated during climb – but not maintained. This is one reason why altitude/position predictions continuously change during VNAV climbs.

In contrast a typical VNAV descent begins prior to top descent, when VNAV calculates a three (*four*) dimensional path in space-time which VNAV attempts to maintain during the descent, sacrificing speed (*or adding thrust*) where required in order to keep the Pre-determined Path. Typically, this is required because of inaccuracies in the VNAV Descent Forecast Wind data.

The situation at the beginning of this section is one of the exceptions - the occurrence of an At and/or Below restriction on the FMC Legs page during a VNAV SPD climb. If a limit becomes binding on the climb, VNAV will engage in PATH and level off to meet the restriction. If the Altitude Selector is in accordance with the restriction, VNAV will still engage in PATH but revert to VNAV ALT when the restriction is cleared, when VNAV wants to continue the climb – but is stopped by the Altitude Selector.

13.13. Packs Off Takeoff

Packs Off Takeoff is one of those anomalies that requires slightly unusual handling with respect to EICAS/ECL. The Packs are turned off at least 30 seconds before takeoff thrust is applied. EICAS will display ❑ **PACK L** and ❑ **PACK R** (and then … ❑ **PACK L+R**). The crew are not required to action these checklists – quite apart from the 4 minute delay required to run it, leaving the checklists outstanding serves as a reminder after takeoff should their re-instatement be forgotten. The PACK L/R/L+R messages should be acknowledged and cancelled to keep EICAS clear during takeoff.

Overriding the checklists is not correct - if selecting Packs ON with Flaps Selected Up is missed after takeoff, they may well go un-noticed until the 8400 cabin altitude popup and EICAS ❑ **CABIN ALTITUDE** shortly after that.

Once the Packs are turned back on after takeoff, the PACKS L/R messages are removed from the EICAS queue – along with the associated NNM checklists, as long as they have not been commenced (displayed on the lower MFD).

It worth noting that the EICAS Caution ❑ **CHKL NON-NORMAL** does not display while on the runway with ❑ **PACK L+R** active. It should, shouldn't it? You're meeting all the conditions statements.

It turns out that **CHKL NON-NORMAL** only reacts to "Critical" messages – and **PACK L/R/L+R** aren't included in the list.

[] CHKL NON-NORMAL

Condition:	There is a hidden non-normal checklist. All of these occur: • A non-normal checklist is not complete • The ECL is not displayed • The related EICAS message is not shown

It's also worth considering NOT automatically hitting the **CHKL** button after takeoff – see **CHKL After Takeoff … NOT**.

14. Climb, Cruise, Descent

14.1. Top of Climb Checks

Boeing SOP's don't specify a flow or sequence required after Top of Climb (TOC). Many airlines develop their own SOP flow at TOC – Training/Standards have chosen to specify a recommended list of actions and considerations at TOC, as follows.

- Fuel/Time on CFP; Aircraft Trim; CFP Preparation; Complete NOTAM / Weather / INTAM / FCON Review.

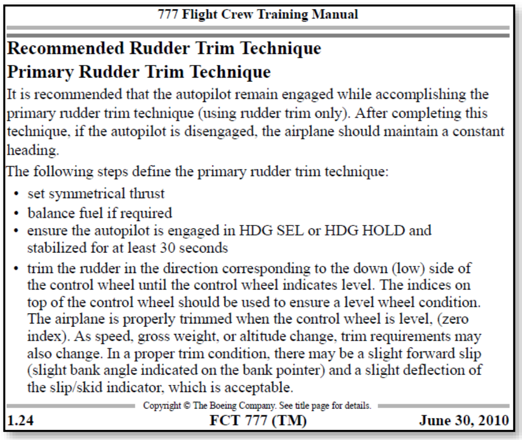
Fuel/Time on CFP

The TOC Time/Fuel should be recorded expeditiously on the CFP against the appropriate waypoint. The enables the calculation of climb fuel/time and can be compared against ACARS Departure Report Takeoff Fuel to also calculate Taxi Fuel. The Fuel on Board at TOC may not be a particularly accurate reflection of fuel progress against Minimum Required fuel (MINR) – the first waypoint after TOC should provide the first accurate indication of fuel status.

Aircraft Trim

Once the aircraft has stabilised in cruise, aircraft trim should be reviewed. It's unusual for one of our aircraft to require more than one unit of rudder trim; but it's not unusual for some rudder trim to be required.

The FCTM provides an alternate rudder trim technique, available if the primary technique results in an unacceptable bank angle or excessive rudder trim. An excessive requirement for rudder trim should be recorded in the aircraft maintenance log. As the aircraft burns fuel and progresses through the flight, trim setting should progressively be reviewed.


777 Flight Crew Training Manual

Recommended Rudder Trim Technique

Primary Rudder Trim Technique

It is recommended that the autopilot remain engaged while accomplishing the primary rudder trim technique (using rudder trim only). After completing this technique, if the autopilot is disengaged, the airplane should maintain a constant heading.

The following steps define the primary rudder trim technique:

- set symmetrical thrust
- balance fuel if required
- ensure the autopilot is engaged in HDG SEL or HDG HOLD and stabilized for at least 30 seconds
- trim the rudder in the direction corresponding to the down (low) side of the control wheel until the control wheel indicates level. The indices on top of the control wheel should be used to ensure a level wheel condition. The airplane is properly trimmed when the control wheel is level, (zero index). As speed, gross weight, or altitude change, trim requirements may also change. In a proper trim condition, there may be a slight forward slip (slight bank angle indicated on the bank pointer) and a slight deflection of the slip/skid indicator, which is acceptable.

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1.24 FCT 777 (TM) June 30, 2010

CFP Preparation

CFP Preparation is covered in detail elsewhere (**Filling in a Flight Plan**) but the following areas need addressing shortly after top of climb:

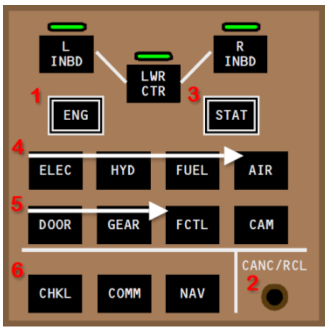
- Completion of the Departure Times/Fuels (Out, Off, Ramp Fuel etc)
- Navigation Log Waypoint Times to the end of the CFP
- EDTO Contingency Summary Page

NOTAM / Weather / INTAM / FCON Review

The pre-flight environment is hectic and often time poor. The essences of the pre-flight documentation review is to ensure a legal and safe dispatch. The review of all Enroute Airport NOTAMS/Weather and FIR specific NOTAMS is not a requirement of this (pre) phase of flight.

However once established in cruise, it's time for the flight crew review completely all the documentation provided for the flight by Navigation Services. The impact of NOTAMS & Weather at non-EDTO airfields and FIR NOTAMS should be reviewed and if necessary, notes made to provide this information to the relief crew for the next handover. Since it's often NOT the Primary Crew who review Departure/Destination/Alternate Weather and NOTAMS during pre-flight - this is the time for those areas to be reviewed in detail to ensure nothing was missed.

Systems Review ([Very] Optional)



If desired, the PF could consider a system review of the aircraft at top of climb. It must be noted that this is for personal awareness only and is not a required procedure. When reviewing systems pages, you're not expecting to find anything unusual – that should have been notified by EICAS.

- EFIS **ENG** for Sec Eng Indications → EICAS **Recall** (Messages, Exceedances); **Cancel**
- EFIS **STAT** review Status Messages.
- EFIS **ELEC** / **HYD** / **FUEL** / **AIR** / **DOOR** / **GEAR** / **FCTL** Systems Pages
- **FCTL** – Consider Aircraft Trim and trim the rudder as necessary
- **CHKL** – Should show the Descent Checklist ...
- FMC **VNAV < ENG OUT** Maximum Altitude/Speed for Enroute terrain awareness.
- FMC **FIX** and **ALTN** Pages for EDTO Alternates / Enroute Situational Awareness.

14.2. Filling in a Flight Plan

The following is a recommended method for completing the CFP. Note that there are sections on completing the "Weights" section (**Checking the Preliminary Loadsheet** and **Accepting the Final Loadsheet (FLS)**)

	TIME	FUEL
TRIP	15:09	125394
CONT	00:14	2000
DEST TFC	00:00	0
DEST WX	00:00	0

	SCHED		PLAN	REV
STD	03:40	ETD	03:40	03:45
TKOF	04:10	TKOF	04:10	04:00
LAND	19:19	LAND	19:19	
STA	19:25	ONBLKS	19:25	
ETA	19:09			

Airborne : The CFP Pushback (ETD 03:45), Airborne (TKOF 04:00) are typically filled in after top of climb. At this point it's not a bad idea to make a note near this block of the ETA (19:09), based on Off (04:00) plus the CFP Flight Time figure (15:09).

Summary Page

The next step could be to complete the EDTO block. The Off time from the Departure airfield propagates through a series of places in this section of the CFP.

EDTO Entry/Exit : The Off time is written under the ATD column to provide more accurate estimates for the first EDTO Entry and the last EDTO Exit points. These can be displayed through 451nm range rings on the FMC Fix pages based on the two selected airports. Note the airports used to define EDTO Entry and Exit may not be EDTO alternates themselves.

EDTO ENTRY/EXIT POINTS

	LAT / LONG	ATD	EET	ETA
EDTO ENTRY (EA1)				
BASED ON KLAX 435nm BEFORE AFONE	N29 238 / W125 269	04:00	01:07	05:07
EDTO EXIT (EA5)				
BASED ON YBBN 256nm BEFORE NATLI	S28 432 / E161 301	04:00	12:46	16:46

ENROUTE AERODROME VALIDITY PERIODS

ETD 04:10 ATD 04:00 +/- -10 MINS

	EARLIEST ETA	REV	LATEST ETA	REV
KLAX (EA)	04:10	04:00	10:22	10:12
PHNL (EA)	10:19	10:09	14:04	13:54
PHNL (EA)	10:19	10:09	14:04	13:54
NSFA (EA)	13:52	13:42	18:18	18:08
NSFA (EA)	13:52	13:42	18:18	18:08
YBBN (EA)	18:06	17:06	18:20	18:10
YBBN (IA)	18:20	18:10	19:25	19:15
YMML (IA)	19:25	19:15	19:26	19:16

EDTO Alternate Validity Periods : This section can be used during pre-flight weather and NOTAM review as a guide to validity period requirements. Once airborne, use the Off time (*more easily, the difference between Off and Sked Out time*) to update the Earliest and Latest ETA's for the EDTO alternates.

Critical Fuel Summary : Here the provided EET figures are added to the Off time to calculate estimated times for the Critical Equi-Time points of between the various EDTO airports. These times can be placed in the fix pages for a reasonable representation of the ETP's between enroute EDTO airfields during cruise. Note that also stated here is the **Non EDTO Distance** (451) which rarely changes; the **EDTO Operational Limit** (180 mins) which can be affected by the DEG/MEL, and the **EDTO Distance** (1227), which can be varied at time of dispatch using an alternate speed schedule.

CRITICAL FUEL SUMMARIES

MAX EDTO 180 min	EDTO DISTANCE 1227 NM	NON EDTO DISTANCE 451
	PHKO- KLAX (EA4)	
DIV FUEL: 24300	ETP B/U: 3278	ANTI-ICING APPLIED: 634
FUEL IN EXCESS TO CP/ETP REQ: 2010		FUEL REQ: 120586

		EET	DIST	WIND	IDENT	ALT	HOLDING
RET:	PHKO	03:01	1028NM	265/028	DP1	FL 140	0 MINS / 0 KG
CONT:	KLAX	03:01	1176NM	234/037	DP1	FL 140	0 MINS / 0 KG

Navigation Log – Waypoint ETA's

Once airborne, the Navigation Log should be completed for the waypoint ETA's. The Airborne time (04:00) is placed at the top of the first page, and then a column of additions takes place down to the last page of the Navigation Log.

A crosscheck at the bottom of each page of the Navigation Log (including the last) ensures that calculation errors are not carried through the flight plan to the cross check at the end.

The ACARS COM Company Departure report contains the fuel on board as the aircraft commences the takeoff roll (134.5). This value is a meaningful cross check against the first A.FREM/P.FREM at the top of the first page of the Navigation Log.

Virgin Australia International Flight Plan 05Nov17 **VOZ 24** VHVOZ FPID: 69096201 Page 7 of 17

AWY FIR LSALT	POSN LAT LONG	FL CLB+	WIND TDV TEMP	MTR TTR	DIST REMD	TAS MACH GS	ETI ACTM REMT	ETA RETA ATA	A FREM P FREM MINR	F USED FOD
NOTES:								STD: 03:40 STA: 19:25	COMPANY FREQ 131.875	
								04:00	134.5	+2.4
128FT 	**KLAX25R** N33 56.5 W118 24.5				0 7027		00:00 00:00 14:49	04:00	 134045 132045	
DARRK1 **12900**	**DOCKR** N33 55.9 W118 27.5	CLB	M10 ISA+3 P15	244 256	4 7023		00:02 00:02 14:47	04:02	 133169 131169	
DCT 1500	**33N30** N33 00.0 W130 00.0	300	M47 ISA+6 M38	252 265	133 6411	498 83 451	00:17 01:28 13:21	05:28	 115964 113964	
							04:00 05:28 ✓			

Navigation Log – In flight record

The Navigation Log pages of the CFP should form a Log of the Flight.

At least every 60 minutes as a waypoint is passed in flight, the actual time and fuel on board (*FMC calculated figure*) should be recorded in the space provided. See **Totalizer vs Calculated Fuel** for a discussion of Calc/Totalizer Fuel anomalies in cruise.

0615z
↗ FL320 ATC
HF
5656/3467

AWY FIR LSALT	POSN LAT LONG	FL CLB+	WIND TDV TEMP	MTR TTR	DIST REMD	TAS MACH GS	ETI ACTM REMT	ETA RETA ATA	A FREM P FREM MINR	F USED 05:28 FOD
DCT 1500	**31N35** N31 00.0 W135 00.0	300 FL300 200/13 -42	P6 ISA+6 M38	232 TAS 498 245	282 GS 500 6129	496 83 502	00:34 02:02 12:47		06:02 110564 108564	110.7 +2.1
DCT 1500	**(EA2)** N29 03.6 W138 46.0	300	P52 ISA+5 M39	227 239	228 5901	494 83 546	00:25 02:27 12:22		06:27 106635 104635	106.7 +2.0
DCT 1500	**DIALO** N28 42.1 W139 25.6	300	P52 ISA+5 M39	226 238	41 5860	494 83 546	00:04 02:31 12:18		06:31 105931 103931	106.0 +2.0

W/UP
06:45

Once the Rest Pattern and EDTO data has been calculated, writing these times on the CFP Nav Log page can serve as useful reminders in flight for these events.

Additional events can be logged by a conscientious crew. The intent of the navigation log is to provide the crew (*or the relief crew*) with the means to ascertain what happened previously; it also allows a follow up process to evaluate the flight after the event.

- ATC Frequencies VHF/HF (& SELCAL Status)
- Direct Routings
- CPDLC Logons and Transfers
- Enroute Climbs, Descents, Speed and Time constraints
- Off route diversions due weather
- Wind Uplink Update

Apart from flight navigation events, the CFP is often used to record other flight related events such as push back delay factors, passenger/cargo loading issues, passenger medical issues, etc.

See **CFP Completion Post Flight**.

14.3. EDTO Critical Fuel Check

EDTO Additional Fuel (EDTO ADDNL) is planned when the fuel required to complete the most critical EDTO diversion from an ETP is less than the fuel required to continue the flight under normal operations and land at the Destination with FINAL RSV + ALTN fuels intact. Typically, this occurs on sectors where the distance between the Destination and Alternate is relatively short.

	TIME	FUEL
TRIP	13:35	110163
CONT	00:20	2703
DEST TFC	00:00	0
DEST WX	00:00	0
ALTN KONT	00:24	3476
ALTN WX/TFC	00:00	0
FXD RES	00:30	2976
ETP B/U	00:33	3278
RCL B/U	00:00	0
MIN REQD	15:22	122596

When EDTO Critical Fuel is present on the CFP, it's good practice to check and occasionally monitor the margin between EDTO Diversion Fuel and Estimated Fuel on Board at the most fuel critical ETP (*usually the last one*).

The CFP Navigation Log Minimum Required Fuel (MINR) column does not reflect any requirement for EDTO Additional Fuel, so regular fuel checks may not detect a developing low fuel situation with respect to EDTO diversion fuel. Additionally, if the CFP Navigation Log does not incorporate waypoints for the ETP's, so the FMC must be utilised to determine fuel at a crew constructed waypoint at the ETP.

CRITICAL FUEL SUMMARIES	
EDTO DISTANCE 1227 NM	NON EDTO DISTANCE 451
PHKO- KLAX (EA4)	
ETP B/U: 3278	**ANTI-ICING APPLIED:** 634
2010	**FUEL REQ:** 120586

The fuel critical ETP can be identified from the EDTO section of the CFP – if EDTO ADDNL was required, the ETP B/U will be greater than Zero**.** This waypoint can be constructed in the FMC – the most reliable method tends to be to use the CFP Lat/Lon co-ordinates. The ETP Lat/Lon waypoint can be entered in Fix page to highlight awareness of the aircraft approaching the ETP. Then as you near the ETP, line select from the Fix page into the Progress Page over the destination for a direct to fix Time/Fuel estimate to copy to the CFP. The CFP numbers EDTO related waypoints from EA1 (Entry) through EA2 (first ETP) and onwards through to the EDTO Exit. When building these waypoints, it's recommended to put the EA? Number as a distance around the Fix entry to highlight the reference to the CFP.

It should be noted that in situations where the fuel estimate at the ETP calculated early in the flight is inadequate – the crew should commence a critical thinking process to determine the accuracy of the FMC estimate and the minimum required figure. However, at the planning stage contingency fuel is required on the EDTO diversion; once airborne this requirement no longer applies.

14.4. Low Speed Climb and FL200

If you haven't seen it before, a low(er) IAS climb (ATC, turbulence, etc) can catch you by surprise as you climb through FL200. At this point the basis of calculation of the Low Speed Manoeuvre Margin changes from one based on VREF 30+80 to that required to provide a 1.3g manoeuvre capability – and the amber manoeuvre margin jumps up as you climb through FL200. The FCOM recommends keeping at least 15 knots above Min Manoeuvre to remain clear of "**AIRSPEED LOW**". You might even want a bit more than that.

See **How Slow can we Go?** For further discussion on low speed flight at altitude, particularly in reference to the **QF** occurrence.

14.5. EDTO Critical Fuel – Do We Need It?

EDTO planning requirements specify fuel required for a Critical Scenario from the ETP between selected EDTO Alternates (*whether more than one is selected*). When finalising the fuel order, crew operating flights with EDTO ADDNL fuel should bear this requirement in mind when considering extra fuel.

> **8.5.11.8 Fuel Monitoring**
> 8.5.11.8.2 For the purposes of the Quality Assurance System, when overflying the computed EDTO Critical Point (CP) the flight crew must record the following fuel quantities:
> - Fuel Onboard (FOB), based on FQIS;
> - Required minimum diversion fuel, based on the OFP Fuel Log. The fuel required at the most limiting position i.e. EDTO diversion point is provided in the Critical Fuel Summaries section of the OFP.

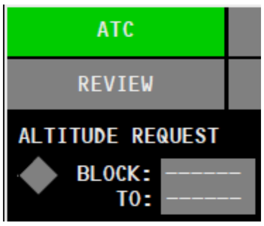
However, depending on your Airline Policy, once dispatched, your flight may not be required to meet this critical fuel requirement. In fact, if the flight dispatches with minimum fuel and the flight proceeds normally, extra fuel available at the EDTO critical point may only consist of un-used taxi fuel and any fuel saved enroute – depending on whether your airline plans the critical EDTO segment with any additional fuel.

That said, it is incumbent on the flight crew to ensure the critical EDTO ETP is reached with an adequate minimum fuel. At planning stage critical fuel includes contingency, icing, holding and other margins that may not be required once airborne. Additionally, for the critical fuel scenario to be realised in flight, the aircraft would have to suffer the relevant failure(s) at the ETP – a failure before or after the ETP would result in extra fuel being available to the flight.

14.6. Use of VS to change Level at Higher Altitudes

The use of VS/FPA (*and to a lesser extent FLCH SPD*) to change altitude at high altitudes constitutes a higher workload on the flight deck and comes with issues related to the use of IAS as a controlling auto flight parameter at high altitude. VNAV is generally the preferred solution. See **Block Clearances**.

14.7. Block Clearances



ATC Block clearances allow the aircraft to operate at any altitude within the cleared block limits. Climb or Descent within the block is at the behest of the crew. While traditionally used to maintain the most optimum cruise level to reduce fuel usage, block clearances have also been useful to find an altitude between traditional RVSM levels that provide a smoother ride.

One crucial aspect of a block clearance during augmented operations is the clear communication of the clearance to the next crew during handover.

VNAV to Change Level

For altitude changes of 100 ft in the block level, VNAV provides the lowest workload solution through a simple twist and press of the altitude selector. The FMA does not change and the FMC Cruise Altitude is updated automatically. Thrust increases to maintain the FMC commanded Mach while the elevators pitch up to climb the 100 ft to the next level. Thrust and pitch change are minimal resulting in smooth ride for the passengers. Altitude changes of 200 ft or more however will result in the usual two rounds of FMA changes and the application of slightly more thrust and pitch.

AFDS Basic Modes to Change Level

For level changes in excess of 100 ft in the block, some crew prefer **VS** +100 fpm (or **FPA** +0.1°). This is a higher workload/higher risk solution and it should be noted that any time a basic AFDS pitch mode is used at higher altitude, the AFDS Thrust Mode will default to Indicated Airspeed (IAS) – ***this should be changed to Mach***. IAS as a commanded auto-throttle parameter during level changes at high altitude can expose the aircraft to high and low speed limit excursions. Note also that the FMC Cruise Altitude will need to be updated during the level change – this can be done anytime by pressing the altitude selector. When the level change is complete – even if another level change is expected shortly thereafter – the AFDS should be returned to **VNAV PTH**.

In essence, use of VS/FPA (and to a lesser extent FLCH) at higher altitudes to change levels is considered a high workload solution to a problem that VNAV was designed to address with greater ease.

14.8. Hand on the Speedbrake Lever

If the Speedbrake lever is extended, it is recommended for the PF to keep a hand on the lever until it is stowed again. This generally precludes the likelihood of levelling sometime later with simultaneous Thrust against Speedbrake and an EICAS ❑ SPEEDBRAKE EXTENDED caution message. If PF needs to switch something, dial something, or scratch something – once complete, a hand should return to the Speedbrake lever again.

14.9. Updating FMC Winds

The winds provided to the FMC through ACARS uplink are produced for four cycles daily at 0000z, 0600z, 1200z and 1800z. These forecast winds are available in the ACARS system after four hours.

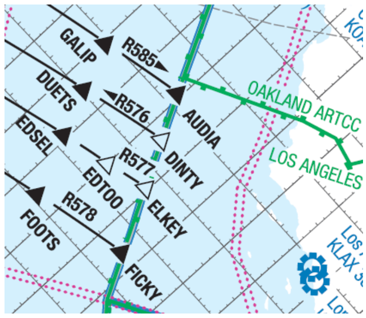
However once in Flight Plan Manager, they are further updated for the inclusion of icing data for the purposes of diversion scenarios, which can take up to an hour. This process should be complete by by **0500z**, **1100z**, **1700z** and **2300z**. This is the theory – in practice it seems to vary somewhat. If you believe your winds are out of date **and** inaccurate, a request for a set of updated winds from the CDU LEGS Route Data page can assist.

Note that you can pre-select the levels in the LEGS page you wish to receive the winds at. This is best done by deleting ALL the existing levels in the LEGS RTE DATA Waypoint WINDS page in the FMC, replacing them with your own (*nil wind will show and these levels will propagate forwards and backwards through the FMC LEGS waypoints*), executing the modification and then requesting new winds. The uplinked winds will be appropriate to the entered levels.

You might want to do a route copy before you undertake deleting all the winds out of the FMC, just in case the new ones don't come down. Additionally – requesting an update of the Descent Winds (*from the VNAV DESC FORECAST page*) prior to top of descent gives you the best chance of an accurate VNAV Path to follow.

Finally, if you have trouble uplinking winds (*as in not receiving them*) then one common cause is a full/stuck FMC/CDU buffer (*assuming the back-end office systems are working ok*). While a review of the CDU COMM page can show you existing stored uplinks that are waiting to be **LOAD**ed or **REJECT**ed; similarly, the RTE Page 1 and RTE Page 2 can indicate the **<LOAD** and **REJECT>** prompts indication that the CDU is full of (*perhaps*) unwanted uploads. Note these last two **may not show on the CDU COMM page**.

14.10. Paired Oceanic Transition Waypoints



Typically, on a long-haul flight, the STAR, Approach and Runway will be entered into the FMC well before descent into destination. This is generally good practice and encourages forward thinking, as well as more accurate fuel/time predictions from the FMC and IFE.

However, the inclusion of a STAR into the FMC is usually in contradiction to the airways clearance the aircraft operates under for most of the flight – which is typically from the last oceanic waypoint (such as FICKY) direct to LAX VOR. When you insert a STAR after FICKY, eventually CPDLC will report to KZAK Oceanic Control that you've been playing with the FMC again – and an automatic warning is generated. This typically results in a "**CONFIRM ROUTE AFTER ____** " message.

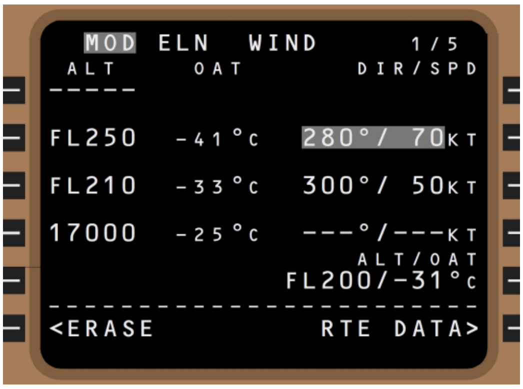
The secret to avoiding this issue is to use the paired oceanic transition waypoints when flight planning. As a specific example, suppose you are planned into KLAX via EDSEL -> FICKY. While the boundary may be FICKY – Oceanic will typically transfer you to LAX Centre prior to EDSEL and log you off CPDLC. Thus, as long as there is two CFP waypoints between you and your first inserted STAR waypoint – you won't set off any alarm bells with KZAK. One might almost think they were designed that way …

Note that CPDLC typically reports position (*including the Previous, Next and Following Waypoints*) every 8 minutes or so. Hence you can't sneak past EDSEL thinking you'll get as far as just before FICKY if you haven't been cleared off CPDLC.

14.11. Route Offset via Track/Heading Select – Not via LNAV

The Route Offset feature of the FMC is used quite often during line operations. However, when manoeuvring across to the new offset route, crew should not allow LNAV to self-position across 20 miles of airspace to the new route – usually Track or Heading Select is used first to positively control the aircraft to the new route. Don't forget to arm LNAV when your intercept heading/track is set.

14.12. Manually Loading Winds



So, this is what it's come down to – uplink has failed to load any or sufficient winds and you're relegated back into the 90's when we were manually entering some or all of the winds. Are you sure this can't wait until the other crew have come back from rest? They need something to do to keep them awake, surely.

A couple of points to note before some more general advice on entering winds. Note the following advice applies equally to uplinked winds as it does to manually entered winds.

- **LATERAL** : The first entry of a wind at each altitude propagates that wind forward and backward through all waypoints in the LEGS page.
- **LATERAL** : Subsequent wind entries at that altitude propagate that new wind down route through the LEGS page waypoints, but not back if there is a previously entered waypoint at that altitude.
- **LATERAL** : There is no interpolation of winds along the route between entered winds at waypoint. All waypoints following an entered wind will inherit that previous waypoint's wind until a new entered wind is encountered, and so on.
- **VERTICAL** : If the Cruise Altitude (*or Step To Altitude*) is above the highest entered wind; that highest wind is propagated upwards without change. Or notice.
- **VERTICAL** : Winds at the bottom LEGS RTE DATA WINDS altitude wash down linearly to 000/00 at sea level.
- **VERTICAL** : For winds at two levels at the same waypoint, between these levels any forecast wind calculation is interpolated linearly between the two vertical winds.
- **TEMPERATURES** : The FMC permits entry of a single altitude/temperature at each waypoint. This temperature is then washed up/down using standard lapse rate at that waypoint. While this temperature is used by the FMC to predict optimum step climbs – the MAX ALT on the CDU Cruise page uses ambient temperature at the present altitude (using standard lapse rate to predict temperature at altitude) only in predicting altitude capability.

Got that? Ok let's get practical.

Once you understand the above, next thing you have to remember is – **Garbage In, Garbage Out**. If your FMC has cruddy winds; you'll get cruddy predictions, and cruddy advice on Step Climbs and Recommended Altitudes.

Clearly if your flight involves 3 levels or less, the 4 levels of FMC forecast winds will meet all your needs. Winds for the levels you'll be cruising at, and at the level above towards the end so step climb prediction gives good information about possible further climb when you're at your last level.

Squeezing the friendship … ok, four cruise levels on the flight plan is satisfied by four levels of forecast wind in the FMC, at least for predicting time/fuel to destination.

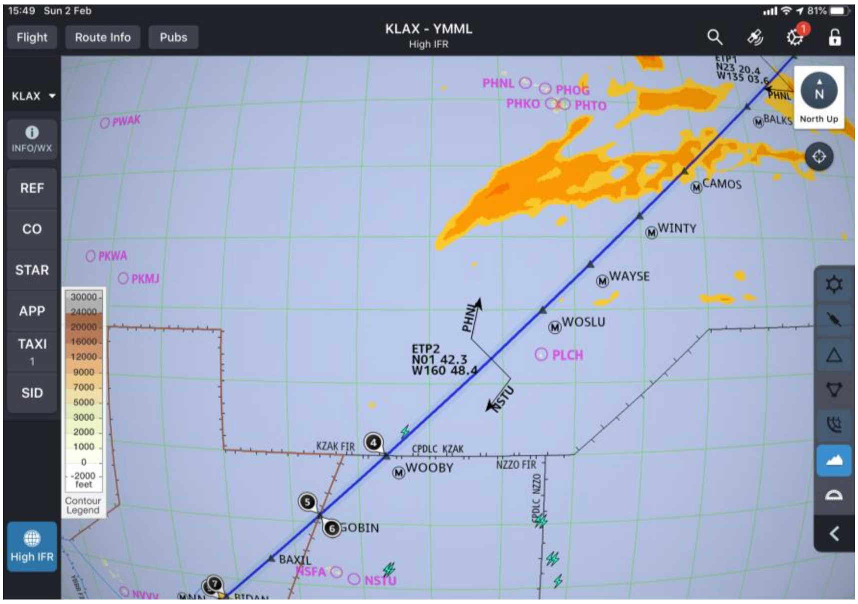
So, what do you do when you need more than four levels of winds? See … **When Four Winds is Not Enough**

14.13. When Four Winds is Not Enough

There are a couple of useful rules of thumb when needing to enter winds for four (*or more*) levels of step climb on a flight plan.

- Always ensure that the highest level you'll reach is covered by a forecast wind level (*or a forecast wind level above that*) in the LEGS RTE DATA WINDS pages.
- Generally speaking, if you have to skip a level – skip one of the levels towards the end of the flight, providing winds for the last cruise level, but not necessarily the level before that. This means that all levels will have forecast winds of some sort, and you can give a more complete set of forecast winds to the first third of the flight. In this way you'll get better prediction/forecast of step climbs when you need them, which is now. As you climb, delete the lower levels you don't need and replace them with the ones down route that you previously sacrificed, to eventually include the level above that which you expect to climb.
- Typically, at any waypoint - you want the wind you'll be cruising at; at least the wind above that; and in a perfect world the wind below.
- Finally, again at any waypoint you want to enter the temperature/altitude for the next level up to more accurately predict altitude capability. ISA deviation typically has little impact on level cruise performance, but errors in deviation vertically can lead to poor step climb prediction.

14.14. EDTO Plotting Chart



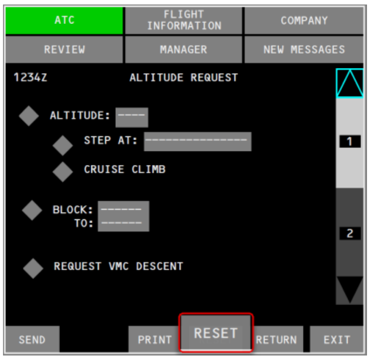
If your nostalgic – you have a plotting chart on your aircraft and series of coloured markers and time to kill. Ideally this is completed pre-flight, but can be left to be completed before EDTO entry. A suggested representation of the required positions is below.

When marking the route to be flown, include the names of **Waypoints** (ELKEY, 20N30, etc) as displayed on the OFP, EDTO **Entry** (EEP) and **Exit** (EXP) Points and EDTODP's (Decision Points or ETP's). Indicating at the ETP's the two EDTO airports considered can improve subsequent situational awareness when reviewing the plotting chart. Note that while the flight may pass in and out of EDTO threshold range (451 nm) of various airfields enroute – only the first EEP and last EXP need be plotted on that chart.

When plotting the ETP with a critical fuel requirement (normally the last ETP on a flight inbound to KLAX, see **EDTO Critical Fuel Check**) – fuel required to divert from the ETP to the EDTO Airfield – highlights the critical nature of that particular ETP.

On a re-clearance flight plan, the re-dispatch waypoint should also be plotted. Meteorological phenomena such as areas of turbulence, cyclonic and volcanic activity may also be plotted. On the other hand, if you have the Jepp App … **do it there**.

14.15. RESET That CPDLC Request

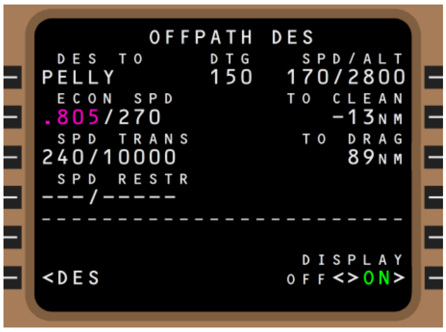


Occasionally a CPDLC request is abandoned prior to being sent. Maybe the air smoothed and you decided against that climb to Max Alt. Maybe the cell ahead isn't looking so bad after all. Maybe you were playing with the pages and putting all sorts of numbers in all the boxes to see what they do.

Ensure you RESET the page before you leave it, otherwise it will hang around and get you back later on. For example – say you were considering a climb to FL340 and entered it into the ALTITUDE REQUEST page. Then the PF changed mind and asked instead for you to request Left 20 miles weather deviation. Dutifully you select the ROUTE REQUEST page, enter the deviation, and hit SEND. What you've just done is requested both a Level Change to FL340 and an off-route deviation due weather.

A clue to the fact that this is about to happen is the VERIFY prompt in place of SEND.

14.16. Monitoring Descent Profile



It is quite important to monitor the VNAV profile calculation on descent. VNAV is the result of a computer calculation and the old adage of Garbage In / Garbage Out holds true (*who fed VNAV the garbage?*).

This check is best done through the basic 3x Height calculation, with an allowance for deceleration. Generally, at 320 knots an additive of 20 miles (*adjust for tail/head wind*) is pretty good. At 250 knots, 8-10 miles in excess of 3x Height should be sufficient. An additional correction of 1nm per 10Kts of Head/Tail wind works as well.

The FMC VNAV -> DESC Offpath Descent energy management circles can also be a useful tool if used properly.

14.17. Big Font, Little Font – the VOR/DME Ident

The Boeing nomenclature for displaying VOR/DME idents on the Nav Display can be misleading, in the least. The VOR/DME receivers are tuned by the CDU's which then seek to interpret the received ident. Co-Located VOR/DME transmitters include idents for both the VOR and DME (usually the same ident) with the DME ident audible at a higher pitch.

- If no ident is received, the ND displays the frequency of the tuned navaid.
- If the VOR ident is received (irrespective of DME Ident reception) a conventional (large font) ident is displayed.
- If the DME ident **only** is received, the ident is displayed in a smaller font.

The display of a smaller font ident is commonly miss-interpreted as an identified VOR. In fact, it is an indication of the receiver's **inability** to identify the VOR. It should also be noted that the ident displayed by the CDU may not match the database stored ident for the navaid - with no visual indication of the miss-match (*incorrect Ident remains green*).

14.18. Crew Handover Briefing

The operating crew will conduct a briefing as part of the handover process to a relieving crew on augmented operations. The content of the briefing will vary depending on the circumstances of the flight, but the following points should be considered. Typically, it is the responsibility of the PF to conduct the brief – while this can be delegated, all flight crew should be present for the briefing and play an active (*listening*) role.

This brief (*like all briefing*) benefits from a quick review prior to the arrival of the next operating crew on the flight deck. A review of EICAS (Recall/Status); ATC COMM (*communication history, outstanding ATC Requested Reports*), EDTO Alternate Weather and CFP Fuel/Time progress covers most of the regular briefing areas.

Aircraft :	Aircraft Serviceability (Recall/Status), CFP Fuel/Time Progress, Fuel System Configuration, etc.
ATC :	Current VHF/HF/RTP usage, outstanding ATC requests (FIR Frequency changes, CPDLC Report Requests, Speed/Altitude requirements, Block Clearances, etc.)
Route :	Route related issues such as significant terrain/escape routes, route offsets for Weather/SLOP, EDTO Status (position relative to ETP, EDTO Airfields, etc.), Fix Page usage.
Weather :	EDTO Forecast/Observation validity & content, updated Destination / Alternate weather, FMC Wind Uplinks, Enroute weather.
Cabin :	Review any significant cabin communications/events, status of cabin crew rest (who's acting/FM), Meals available/consumed, etc.
Other :	Initial Rapid Descent Altitude (FL140/Terrain/FL100); Company messages, Wakeup rules, etc.

During crew changes the speaker should be on to ensure communications continuity, the AP must be engaged, and each crew area should be neat and tidy with maps and documents in their standard locations. Note that the A1 forbids any crew change below 10,000 ft; any change of Aircraft Commander below FL200.

Prior to leaving the flight deck, the PIC should consider discussing with the operating flight crew the severity of any non-normal events that require PIC notification and the level of operational decisions that require PIC authority.

14.19. Runway, Approach and STAR Selection – Confirm … Execute

While the order selected usually makes no particular difference to the result – choosing the **Runway / Approach** then the **STAR and Transition** generally speeds the process of entering these when setting up for the arrival. Approaches and the STARS/Transitions are filtered by first selecting a Runway / Approach. Similarly, on departure – select Runway, SID, Transition.

"**Confirm … Execute**" is not just best practice – it's SOP. As PF (or PM) when selecting the arrival procedures from the DEP ARR page – ensure you **Confirm** … **Execute** what you have selected with the PF **before** moving on to the LEGS and other pages to verify and modify your arrival. The selection of a runway, approach, STAR and any associated transition are crucial elements that **must be verified by the other pilot before you execute** – the only way to really do this is **before** you leave the DEP ARR page.

"**ILS Runway 25L, Buffie Two STAR, Santa Monica Transition – Confirm?**"

If LNAV is engaged – the PF should verify via the LEGS page that the active leg is unaffected before confirming the execution.

14.20. HF Radio Usage

HF usage is taught during line training. The following points are worth considering.

> **"Brisbane Radio, Brisbane Radio, Velocity Two Datalink on Five Six Three Four ..."**

- Use the Left RTP for HF-L and the Right RTP for HF-R to avoid confusion.
- Using HF-L for the primary ATC frequency and HF-R for the secondary also helps. Having the secondary on HF-R means the frequency is available for SELCAL in case the primary has failed.
- When given 4 frequencies (*such the initial contact with San Francisco Radio providing a changeover at 140 West*) setting both Primaries in HF-L (*140W frequency in the Standby*) and the Secondaries in HF-R again keeps a familiar usage pattern.
- Remember ATC will have a squelch facility in place on HF. As such the first syllable or so of a transmission may be lost (*hence the "***Brisbane Radio, Brisbane Radio ...***"*). Also leaving gaps between the words of your call means some words may be lost as the squelch breaks up your transmission. So, slow your speech down, speak a little louder and run your words together a little. Sounds like late Friday night at the pub really …
- Initial calls to ATC on HF should include the HF frequency being used. ATC often monitor more than one HF frequency at a time, and it can be a challenge to work out which frequency you're calling on without this.
- Adding "**Datalink**" to your call sign – assuming you have a CPDLC logon with the FIR you are trying to contact – reminds ATC of this fact (*don't assume you're talking to the same ATCO running CPDLC*).
- Initial calls should also be kept minimal in detail. Don't make a lengthy position report and SELCAL request until you know they're ready to receive it.
- And if you still can't get through to Mumbai after 3 attempts, throw in the words "**Transmitting Blind, Transmitting Blind**" That'll get their attention. Or not.

14.21. Stowing the Speedbrake near VMO/MMO

Stowing the Speedbrake, especially during descent, can result in a momentary speed increase beyond the design limits of the autopilot to counter. As such, when descending at high Speed/Mach with the Speedbrake extended, stowing it quickly can result in a high-speed limit exceedance. This manifests particularly at the bottom end of the Rapid Descent manoeuvre – reducing speed prior to stowing the Speedbrake precludes an overspeed.

14.22. No Published Transition Level

Some Countries/Airfields do not publish a fixed Transition Level on the Jeppesen Approach charts – in this case a Transition Altitude is published, with the Transition Level as (ATC), often advised by ATIS.

TRL ATC
TA 8000

The FMC stores the transition level of the destination airfield in the VNAV DESC FORECAST winds page and this is the reference for the EFIS Control Panel on descent. When no Transition Level is published – the FMC will have the Transition Altitude value stored as the Transition Level instead. The threat here is that if the aircraft levels off at a flight level instead of an altitude near the TA/TL during descent, the FMC will not advise the crew of the requirement to change to QNH via the PFD indications. If the ATIS broadcasts a Transition Level – this should be set on the VNAV Descent Forecast page when received.

Note that anytime you are conducting a descent and the destination airfield in the FMC does not match your actual destination (*or at least the airspace design you are descending in*) then you have the possibility of a miss-match. For example, if a few hours after departure from LAX-SYD you have a Rapid Descent in US airspace – you will find the Transition Level on descent will be FL110 (from the destination airport SYD in the FMC).

14.23. Step Climbs – CFP vs FMC (Optimum vs Recommended vs STEP)

Crew should refer to the Boeing FCOM and FCTM (*and Honeywell FMC Guide*) for a full discussion of step climbs. What will be discussed here is partly a summary, partly a response to questions encountered in this area during line training/line observation.

"The CFP is the Most Accurate"

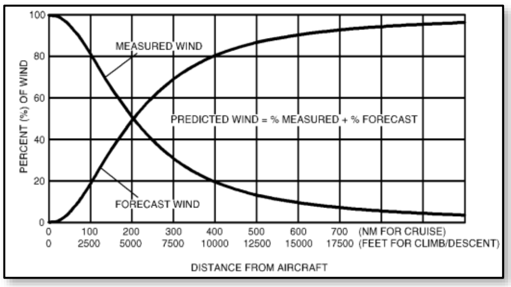
This is generally correct in that (*in most cases*) the computers and software used to calculate the vertical profile of the CFP are far more sophisticated than the computer and software found in the FMC. The flight planning system has access to a more complete performance database profile of the aircraft and a better level of detail of wind data than is accessible onboard. That said there are factors which can affect the accuracy of the CFP, post production. Alternative routes, significant weight and wind changes are amongst them.

Winds : The winds used to calculate a Long Haul CFP can be anything up to 9 hours old at Top of Climb, much older down route. If the crew have reason to suspect that the wind profile used in the CFP is significantly ***different*** than that on the CFP, the FMC (*with updated ACARS winds*) becomes your only remaining solution. Admittedly this is pretty rare but does happen. Note I said "suspect the winds are *different*" rather than *old*.

Weight : The CFP is prepared for a specific aircraft weight (*actually landing weight, flown backwards*). If a significant ZFW change is involved, along with a significant change in Fuel Load, the CFP can be slightly inaccurate. It should be noted that the kind of weight changes that would significantly affect the accuracy of the CFP cruise climb profile should probably have required the crew to order a new CFP...

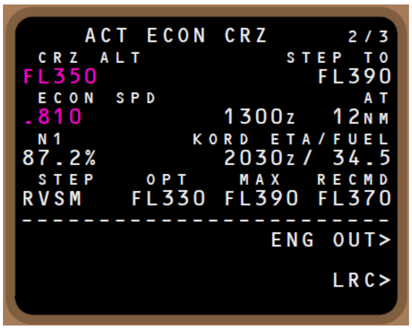
Speed : The CFP's are typically based on minimum cost. Anytime you choose to fly a fixed speed schedule (*faster to make time, slower to make fuel*) the overall cost of the flight increases, and the FMC alters it's OPT/REC/Step climb recommendations based on this speed schedule. The CFP climb points therefore become (slightly) less relevant to the new type of flight being undertaken.

FMC Winds – Forecast vs Actual



The FMC winds are uplinked during pre-flight (see **Uplinked Winds – First Level Missing**), and therefore might well be more up to date than those on the CFP, although not necessarily significantly different. Additionally, crew can request updated winds in flight (see **Updating FMC Winds**). When using wind in the calculation, the FMC uses a mixture of 99% of the IRS Wind (Actual) at the nose of the aircraft and washes it out over approximately 600nm to 99% of the Forecast wind. This washing process is not linear – at approximately 200 miles, about half the actual wind is used in the calculation. As soon as a higher level is being considered by the FMC – only forecast wind is used. The FMC does not wash actual wind up or down through levels.

FMC VNAV CRZ OPT (Optimum Altitude)



When operating in a block clearance, crew will often follow the FMC VNAV CRZ page OPT value, stepping up 100 ft at a time. However, the OPT value takes only Cost Index (*or selected speed*), Weight and Temperature into account – there is no concept of Wind in the OPT value. As such crew may well be costing the flight fuel and time (*and cost*) by not following a wind-based recommendation.

FMC VNAV CRZ RECMD (Recommended Altitude)

The Recommended Altitude includes wind and the OPT calculation to advise the best level for cruising for the next 500 miles or so. RCMD does not look beyond that in recommending altitudes, so potentially it could recommend a climb into a (*much later*) increasing headwind. Standard use of Actual/Forecast along track, up and down apply, and the altitude is based on various combinations of current cruising altitude and the entered STEP size. It should be noted that RECMD can also recommend a descent to lower level.

FMC VNAV STEP TO Time/Dist (Step Climb Point)

The STEP climb calculation completes the picture, using all available information of the OPT calculation and actual/forecast wind along the entire route stored in the FMC, in conjunction with current cruise altitude and entered STEP size to advise the best point at which to commence a climb to the next altitude. Crew should have a valid reason before choosing to deviate from the recommended FMC Step Climb points (*simple reference to OPT or RECMD is not enough*). It's worth noting that your CFP may not be capable of recommending climbs between waypoints whereas the FMC does. On the long legs between waypoints over the Pacific, this can be a significant factor in choosing FMC Steps over the CFP.

Widely Spread Waypoints & STEP TO … Caution

While the STEP TO tends to be the most economical way to operate – beware of FMC STEP TO recommendations that seem out of "step" with the OPT and RECMD altitudes (*often to near MAX*), particularly on a leg segment where the waypoints are separated by significant distances (*such as those across the Pacific*). Anecdotally, this combination can result in a conflict between the FMC's use of near 100% actual wind at actual level against 100% of forecast wind at even just 1000 ft above – resulting in poor recommendations by the STEP TO function away from (seemingly) more reasonable CPF/OPT/RECMD values. Waiting until the next waypoint transfer can often resolve strange recommendations from STEP TO function in this scenario.

14.24. Setting up for Approach – PF or PM?

Setting up the FMC and the aircraft for the arrival is normally the task of the pilot who will be flying the aircraft on the approach. In this way the PF gets to make the various decisions associated with planning the descent and approach. Ideally the PF will hand over control well before top of descent (*therefore becoming the PM*) and will complete a setup and self-brief of the approach, considering all the factors from top of Descent point, through STAR, Approach, Missed Approach, Runway Constraints, Taxi Ways, Parking Stand, Airfield Characteristics, NOTAMS, Diversion Fuel, etc. When this process is complete, control is handed back and the other pilot will check the FMC, prepare charts, etc for approach, and get ready for a briefing. This is also the process used when established in a holding pattern.

In cruise on a nice day, it is not mandatory for this handover to take place. When the workload is low, top of descent is still far away and everyone is awake – PF can retain control for this setup as long as PF retains situational awareness of the flight. PF can also brief an arrival while retaining control – again with the same requirement to maintain situational awareness and function correctly as the PF during the setup/brief.

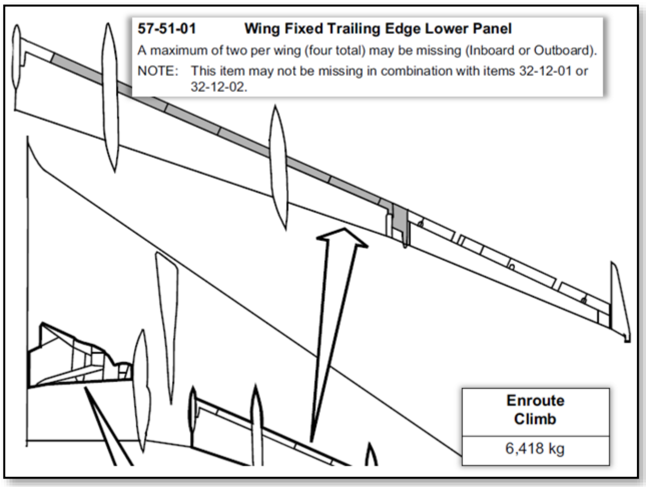
An alternative approach is utilised when FMC setup and briefing must be done during high workloads – such as a runway/approach change during descent, or a setup to be completed after a missed approach. It is always permissible for the PF to direct the PM to complete a setup for the approach, and then if appropriate the PM may brief the PF on the setup. While this process works well for repeating an approach after a missed approach, when it comes to setup for a different approach to a different runway (*either on descent or after a missed approach*) there is still a requirement for a positive cross check of the FMC by the other pilot.

14.25. Enroute CDL Performance Penalties

Some CDL items require the application of performance penalties to either aircraft performance or fuel planning across various phases of flight.

Dispatch

Enroute CDL performance penalties are expressed in terms of fuel flow decrements, with a conversion factor specified in the CDL introduction (eg: 0.25% / 454kg). SABRE's Dispatch Manager has performance PDA and Drag Factor penalties Climb, Cruise Descent and Holding – although only Cruise is represented on the CFP.



See **Application of CDL Performance Limits** for guidance. Ensure the CFP reflects the appropriate performance decrements for the CDL Defect.

Airborne

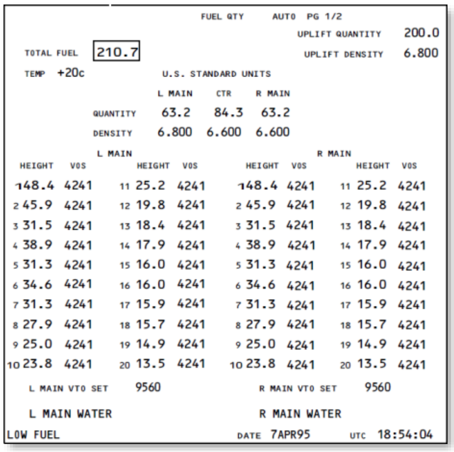
If crew are concerned about cross checking the performance impact of a significant enroute climb performance penalty, there are a couple methods of achieving this.

Crew could ***temporarily*** increase the ZFW of the aircraft in the FMC to obtain recalculated Maximum Altitude values – the displayed limit will be conservative as compared with the true impact of the performance penalty. **Don't forget to change the ZFW back to the correct load sheet value.** Since this change does not require execution, but impacts all performance prediction in the FMC, the impact/risk of leaving the wrong ZFW in the FMC could be significant.

In order to assess the single engine impact of a performance penalty, the VNAV Engine Out prompt would need to be selected after augmenting the ZFW in the FMC – Single Engine altitude capability can be obtained without executing the Engine Out modification.

Finally, QRH data can be obtained by augmenting the actual weight of the aircraft when using performance lookup information in the QRH.

14.26. Totalizer vs Calculated Fuel



Totalizer fuel is displayed on the EICAS as a straight representation of the aircraft FQIS. The FQIS uses 20/28 sensors in each main/centre tank, which listen for pulses send out by an ultrasonic transmitter/receiver. Based on this the FQIS calculates fuel height in the tank and therefore fuel volume, and this volume in combination with the output of mass densitometers, calculates fuel on board. This system is certified based on a maximum error rate of 1% *(steady, un-accelerated flight/ground)* – which therefore implies a maximum error of ±1470 Kg parked on stand with full tanks. It would be reasonable to expect the FQIS to be more accurate than this certification figure under normal conditions.

FMC Calculated Fuel

Calculated fuel *(which is the default value the FMC uses for fuel prediction)* is based on Totalizer when the first Fuel Control Switch is selected to RUN – from this point forwards the total is reduced by measured fuel flow through the Fuel Control Units. While APU fuel burn is not accounted for, the FMC calculated figure is generally considered more accurate, with an error rate of no more than 12% (*of fuel flow*); and a maximum of 0.5% (*of fuel flow*) in cruise. Note that the initial accuracy of Calculated Fuel at Fuel Control Switches to RUN is wholly dependent on the accuracy of the initial Totalizer value.

Totalizer / Calculated Fuel Discrepancies

Most flights are subject to some differences between Totalizer and Calculated Fuel. Significant differences (*3 tons for 5 minutes*) generate an EICAS ❑ FUEL DISAGREE message which may well indicate a fuel leak – but typically differences of up to 1 ton on longer flights are not that unusual.

There are some indications that a combination of aircraft pre-fuelling and high ambient temperatures can exacerbate this issue through the impact of fuel stratification in the fuel tanks on the accuracy of the on-stand Totalizer figure, generating an error that could then be carried into the Calculated value – but as yet these are not proven factors.

From the design of the systems – the Totalizer is intended to convey the fuel remaining on board the aircraft, and should be more and more accurate as the flight proceeds, reaching its highest levels of accuracy as you run out of fuel. Meanwhile the Calculated value, while initially impacted by any inaccuracies in the Totalizer figure at **Fuel Control Switches … Run** – from this point on the Calculated value should be highly accurate.

In Flight Fuel Recording

Since the Totalizer measures a large value for most of the flight (*fuel on board*) while the Calculated measures a much smaller value (*fuel flow through the FCU nozzles*); and the Totalizer is subject to acceleration and turning errors (*despite the baffles in the tank*) – generally Calculated Fuel from the FMC is a more accurate reflection of fuel state. Running a dual column on the CFP of both Calculated and Totalizer tends to bear this out with the Calculated Fuel indicating a general trend with variations that reflect level/speed/wind changes, whereas the Totalizer fuel track can show variations that are difficult to explain. Large discrepancies (>1500 Kg?) typically only develop in association with large fuel loads and long/ultra-long-haul flights. Often larger discrepancies earlier in the flight resolve themselves towards the end. The best way to resolve this situation tends to be reliance on accurately completed CFP to examine the ZFW adjusted fuel burn as compared with the fuel burn progress of the flight. This includes provision for undesirable flight levels and off route diversions of weather or other reasons. The logging of both Calculated and Totalizer fuel may be desirable where discrepancies are anticipated.

Arrival Fuel

The difference between Calculated and Totalizer (*viewed on CDU Progress Page 2*) is worth considering as part of your Arrival Briefing. Some pilots focus exclusively on FMC predictions (Calculated) when considering low fuel operations into destination. Be wary of using FMC Calculated values that are higher than the Totalizer value – differences between the Calculated (FMC) and Totalizer fuel can make your operation less conservative – resulting in either an unintended commitment to destination, or an early diversion to alternate. As previously stated, at smaller and smaller values of fuel on board the Totalizer should be more accurate and is the value of choice for determining fuel on board when it really counts (*that is, when there isn't much of it left*). While not a recommended technique, if the crew determine that the Calculated is in error, the option is available in the FMC to **<SEL>**ect Totalizer instead of Calculated on PROG P2. This should only be considered if the Calculated value is considered to be in error.

14.27. Speed Excursions and Autoflight

Speed excursions in cruise typically result from a combination of flight at or near an aircraft performance limits (*Hi/Low Speed and Maximum Altitude*) and environmental factors. Changing head/tailwinds near jet streams and significant temperature variations associated with crossing jet streams and the tropopause can induce changes in the IAS beyond the immediate ability of thrust required/available to contain – particularly at altitudes between FMC Optimum and Maximum altitudes. Thrust limited aircraft such as the B777-300 and B787 are particularly susceptible.

While this text should not be taken as a restriction on or recommendation against disconnecting the auto pilot and flying the aircraft, pilots must remember that high altitude manual flight is qualitatively different to the usual regime of lower altitude manual flight. While the flight controls are somewhat less effective, aerodynamic damping is significantly reduced and the likelihood of excessive control inputs and subsequent over corrections is high. As such, in the event of an overspeed/underspeed event, using the appropriate autopilot mode to recover the normal speed regime is often a more conservative response than disconnecting the autopilot.

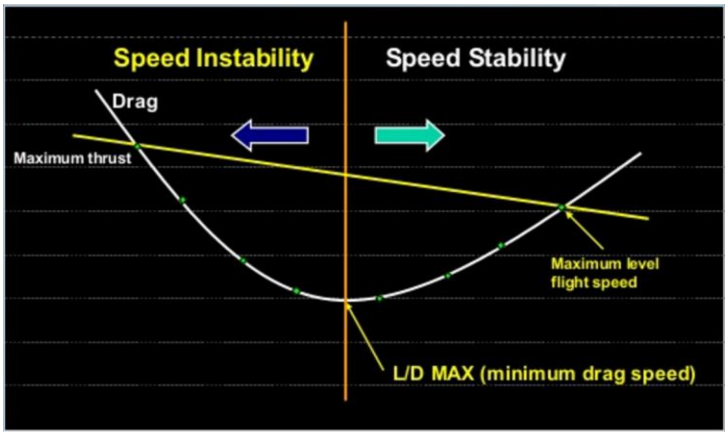
Overspeed in Cruise

Overspeed events are typically the result of a combination of high-speed flight (OTP, ATC) combined with environmental factors such as increasing headwind component or decreasing temperature. For excessive overspeed events in an altitude hold mode (VNAV ALT / ALT) the autopilot will eventually fail the vertical mode and pitch the aircraft up to leave the overspeed condition – but this typically does not take place until VMO +20 knots or so. Prior to this you can expect to see thrust reduce significantly, and the Boeing FCTM recommends against idle thrust at high altitude. The judicious use of partial Speedbrake can reduce overspeed exceedances and hasten the return to normal flying speeds. In such cases the Speedbrake should be extended and retracted slowly. During extreme events a level change reversion to an AFDS pitch based speed mode (FLCH SPD) resolves the event more quickly, albeit with the sacrifice of losing your assigned altitude.

One common error in reaction to an impending or small OVERSPEED incident is to disconnect the Autopilot and pull back. Another common response is manually closing the thrust levers to idle over the action of the Autothrottle. There will be times when disconnecting automation and flying your aircraft is absolutely the best approach. However incident data tells us that this reaction to (*at least minor*) Overspeed events tends to make things worse. We rarely fly the aircraft at altitude and despite the fly by wire magic – the air is thin up there, aerodynamic dampening poor and the controls more effective as a result. Sudden control inputs just after (*or during*) Autopilot disconnect at altitude (*particularly with the Seat Belt signs Off*) can have injurious results. As such the recommendation is to leave the Autopilot engaged, go for the Speedbrake (*carefully*), and allow the Autothrottle to reduce the thrust at it's own pace. These actions are more likely to result in an actual Overspeed annunciation than a more radical set of actions – but a minor overspeed is desirable compared with the injury and disrupt that comes with sudden manual flight and recovery at high altitude from idle engines that take forever to spool up again.

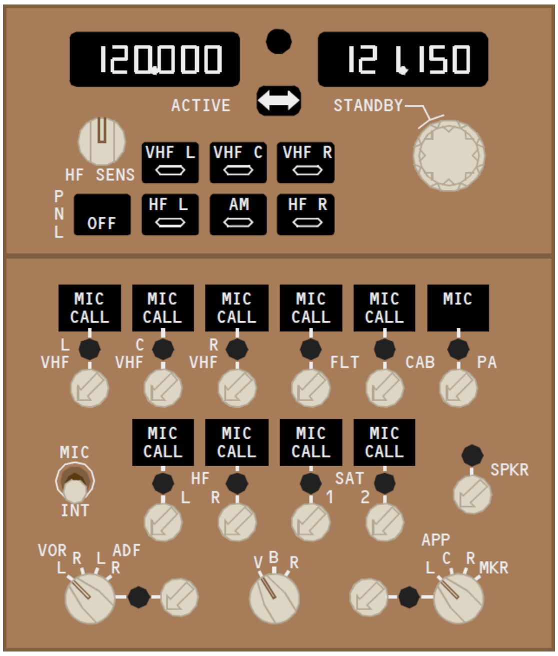
Underspeed in Cruise

The underspeed event in cruise can be the more insidious and arguably more dangerous event. Typically caused by increasing tailwinds and/or increasing temperature – at altitudes near and above Optimum, speed reduction below maximum Lift/Drag (*approximately Manoeuvre Margin +10 knots*) can reach a point where insufficient thrust is available to adequately return the aircraft back to normal cruising speed – a descent may be required. Allowed to continue the aircraft can reach the AIRSPEED LOW alert and eventually stick shaker, where mandatory manual flight intervention should be required.



A more appropriate autopilot response to this scenario is usually achieved through the use of Vertical Speed (VS) rather than Flight Level Change (FLCH SPD) since Vertical Speed will keep the thrust high for the required descent. For a typical low speed encounter into the manoeuvre margin, initial selected vertical speeds of 2000-3000 fpm are usually required to recover normal cruise speed prior to returning to a (*lower?*) cruise level using a more appropriate mode such as Flight Level Change or perhaps VNAV. This manoeuvre should be trained/practiced in the Simulator before being employed in the Aircraft.

14.28. VHF Radio/RTP Usage



There are three VHF Radios (L+C+R) and three Ratio Tuning Panels (RTP L+C+R) in the 777. As discussed in **HF Radio Usage**, each RTP is capable of tuning any VHF/HF radio – which while useful, can lead to some confusion on the flight deck if used inappropriately. Based on A1 recommendations the three VHF radios are used as follows:

- **VHF L** : Primary ATC Communications
- **VHF R** : Monitor 121.5 / Secondary ATC / Company / ATIS
- **VHF C** : ACARS/Datalink Communications

That said, it often makes sense to use VHF-C for Company/Weather when VHF-R is in use for other purposes. Ensure VHF-C is returned to DATA to maintain ACARS VHF capability. As a specific example – during pre-flight, taxi or descent the 1st Observer is often charged with updating the ATIS or contacting the Company. This is best done with minimal disturbance to the operating pilots by the 1st Observer taking VHF-C out of DATA to listen/transmit, and then pass the required information onto the operating crew.

Note that the Center VHF has a poor range airborne in comparison to VHF L/R – this is reversed on the ground.

Offside RTP Usage

By convention RTP-L is used for tuning VHF-L and similarly with RTP-C/VHF-C and RTP-R/VHF-R. Offside tuning of VHF radios through another RTP is a useful feature but can lead to confusion on the flight deck. If you're using an RTP for offside tuning, ensure it is returned to the correct onside tuning state upon completion of use. Offside Tuning of VHF-L (Primary ATC) or using RTP-L for offside VHF tuning is **not** encouraged.

Specifically, when the PRCM/1st Observer is intending to use the VHF-R for ATIS/Company Communications, the following procedure is recommended.

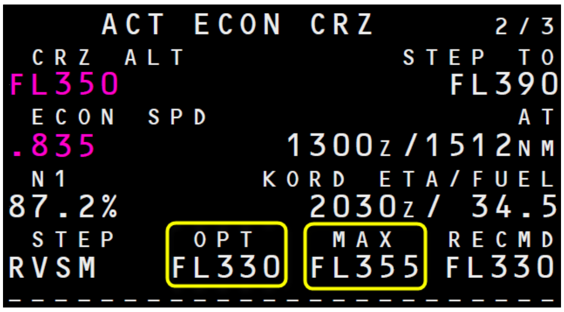
- When VHF-C is not in use, it should remain in DATA to enable VHF ACARS/Datalink Communications.
- Circumstances permitting, VHF-C should be used by the PRCM for all communications – ATIS, Company, Engineering etc.
- When Required – PRCM can use VHF-R for ATIS/Company Communications, as follows.
  - The operating crew should be advised that VHR-R is going to be taken off 121.5 and used by the PRCM.
  - The Captain and First Officer should then choose whether or not to de-select VHR-R audio on their own RTP.
  - PRCM will tune and select the appropriate frequency into VHF-R using the Right RTP.
  - PRCM must advise operating crew when VHF-R is returned to 121.5
  - The Captain and First Officer should then re-select VHF-R audio on their own RTP, as applicable.
  - PRCM should ensure that the Captain and First Officer have returned to monitoring VHF-R once 121.5 is re-instated.

VHF Squelch Disable

The squelch feature of the three VHF Radios can be disabled using the RTP's. Push and hold the Radio Tuning Switch (VHF-L/C/R button) to disable the associated VHF Squelch.

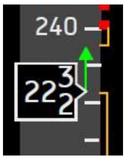
- VHF-L button on RTP-L for the Left VHF;
- VHF-R button on RTP-R for the Right VHF; and ...
- VHF-C button on **RTP-L** for the Center VHF (*no idea why*).

14.29. How High can we Go?



The requirement to cruise above optimum altitude usually relates to either Traffic (ATC) or Weather, and occasionally airspace.

Traffic



Assuming smooth air and clear skies, cruising near Maximum Altitude will likely incur a performance penalty in terms of increased fuel burn and increased cost. While there are a lot of personal preferences – there's no technical limitation on cruising at or near FMC Maximum Altitude. The combination of the 777's wing and engines produce an acceptable margin over high/low speed buffet as well as adequate thrust to hold the required speed. Flight in excess of Maximum Altitude disables FMC predictions, potentially compromises buffet margins, and is not recommended.

That's not to say cruise at Maximum Altitude is "comfortable". Typically, there is a 10 knot margin between PFD low speed minimum and manoeuvre speeds. The auto throttle tends to get lively if turbulence is encountered and the speed varies from target towards either of these buffet margin indications.

Weather

Climbing above cumulus weather is rarely a successful proposition and trying to do so in proximity to maximum altitude hardly improves things. Climbing a thousand feet or so near Maximum Altitude to clear the tops of cloud risks flight at maximum altitude in turbulence.

Another reason to climb in relation to weather tends to be the search for smoother air. If the turbulence you're trying to avoid is essentially speed stable, it might be worth climbing above optimum if you have a reason to believe things will smooth out. However, turbulence and any indication of speed instability are one of several reasons to avoid cruise at or near Maximum Altitude.

14.30. FLCH Descent at 240 Knots

The FMC commands descent below 10,000 ft at 240 knots by default in order to be in compliance with the 250/10,000 speed restriction while still allowing vertical manoeuvring capability for tactical use by VNAV PTH. In VNAF Path, VNAV will increase speed by up to 10 knots below 10,000 ft in order to compensate for an above path occurrence.

Crew transitioning to FLCH SPD for more direct control of the descent – particularly in tactical situations such as Off LNAV path vectoring by ATC – are under no obligation to reduce to 240 knots. FLCH is a speed mode and as any variation from selected speed is minimal – 250 knots is the logical choice.

14.31. Setting VREF Early

Selecting and entering a VREF into the FMC is typically done as part of the setup prior to the Arrival Briefing. There are no specific restrictions or guidelines – crew can use the weight displayed at the time and update later (or not); use estimated fuel burn and the current weight to gain a more accurate VREF (or not); you can check the weight you calculate against the CFP revised Landing Weight – or not.

Setting VREF significantly early in the flight (*for example prior to going for last rest as the operating crew*) exposes the operation to the potential risk of a diversion into an enroute airfield with the incorrect VREF set. Hopefully this would be caught by the crew as part of the descent preparation into the new airport – but some airlines have a specific prohibition on setting VREF earlier than the arrival briefing. Generally speaking Crews are recommended against setting VREF for approach much earlier than the Arrival Briefing.

14.32. How Slow can we Go?

Often there is a requirement to slow down in cruise, particularly towards the end of a flight to a primary control zone. Flight Crew should attempt to comply with ATC requests in this regard within the confines of flight safety. Efficiency of flight goes out the window at this point – although typically it's better to slow down a little earlier rather than go with accepting extensive off route vectoring or holding in close to the destination.

This brings about a question - **how slow can we go**? The Boeing FCTM is curiously absent on this question. If you want a short answer – **use FMC Best Holding Speed**, unless in Turbulence or near Maximum Altitude (*in which case choose something faster*).

If you want to know some background ... read on.

There are several possible answers to this question.

- Turbulence Penetration – IAS 250/270/280/.82M or VMINM +15 knots.
- FMC Best Holding Speed (Beware of predicted speed …)
- UP Speed (below FL200)
- Minimum Manoeuvre Speed.

Turbulence Penetration (VB)

Turbulence Penetration Speed (VB) is just that – a speed chosen for the penetration of Severe (*or more usually Moderate*) turbulence. It's not a speed designed to give a smooth ride to the passengers; it's not a speed selected to provide the greatest compromise between low and high speed stall – it's a maximum speed at which the aircraft is designed to survive a maximum gust of 50 fps/3000 fpm (*yes, this is simplifying it more than a bit*). As such it's not a speed designed to limit how slow you can fly the aircraft. It's not bad choice – particularly if you are being asked to slow down in light or moderate turbulence – it's just that if the air-mass allows and you wanted to fly slower, you could.

*As an aside, in the early days of the 777, turbulence penetration used to be Mach .84 – you'd be cruising along, hit a bump, speed intervene and speed up. It was awesome – we encountered a **lot** of turbulence in those days, particularly when we were in a hurry ...*

On the 777-300 with its higher VMO this had no real issues but on the -200 aircraft, particularly when the turbulence experienced produced indicated airspeed instability – high speed excursions were not unusual past VMO.

Eventually Boeing brought VB back to .82 (and then later modified it to be at least VMINM +15) across the entire 777 fleet to kept us clear of VMO on the -200 and VMINM on the -300/200LR.

Best Holding Speed

Best Holding Speed is usually closer to VMINM than VB but still provides an increased margin of available bank angle (or dynamic increase in aircraft weight) than VMINM. If a hold exists in the LEGS page, best holding speed for the current altitude appears on the Hold Page. Otherwise inserting a present position (PPOS) hold in the flight plan – without executing – displays the best holding speed.

Remember that this speed does **not** account for turbulence. Also, while it does account for weight and altitude and therefore will provide a margin over high and low speed stall/buffet – best holding speed is in fact chosen specifically for maximum endurance – maximum time aloft.

While it's certainly not a minimum speed - the FMC Best Holding Speed is usually a good compromise choice when asked to slow down by ATC.

Note : Be aware (*be very aware*) of the ***predicted*** holding speed on the hold page. This feature tells you what speed the FMC intends holding at – along with the predicted altitude at the hold. That's all well and good and likely to be accurate if you actually take up the hold at that altitude – but otherwise is not a valid speed for your current altitude. Meanwhile if you manually enter a target altitude here, the calculated speed will be appropriate for that altitude – and that altitude alone. This becomes particularly significant if you are comparing speeds between altitudes above and below FL200 – as one B744 crew found out. See also Low Speed Climb and FL200.

Minimum Manoeuvre Speed (VMINM)

By implication this is the lowest speed that should be considered for flight. This speed will be less than Holding Speed and less than VREF 30+80 when below FL200. While still a valid choice, in turbulence it can reduce the margin above events such as auto throttle wakeup, EICAS AIRSPEED LOW, stick shaker and other paperwork generating occurrences that are down linked expeditiously to home base. When cruising between FMC Optimum and Maximum Altitudes in the 777-200/300, slowing towards VMINM could possibly leave the aircraft without enough thrust to recover speed should you have a low(er) speed excursion – a descent would be required. Excess thrust simply isn't available in the 772/3 and anything below approximately best holding speed is well behind the drag curve. The 777-300ER tends to have more thrust in these areas and recovering speed shouldn't be as much of an issue – as long as turbulence (*be particularly wary of mountain waves*) isn't a factor.

FCTM No Hold, No Book, Speed

Meanwhile the FCTM provides some quick reference guidance to a holding speed recommendation when nothing more sophisticated (FMC, FCOM) is immediately to hand. This number is quite conservative – which is probably something you want in a B777 at altitude without and FMC or and FCOM. VREF 80+120 for the B777-300ER.

> **Holding Airspeeds Not Available from the FMC**
>
> If holding speed is not available from the FMC, refer to the PI chapter in the OM. If time does not permit immediate reference to the OM, the following speed schedule may be used temporarily. This simplified holding speed schedule may not match the FMC or OM holding speeds because the FMC and OM holding speeds are based on many conditions that cannot be generalized into a simple schedule. However, this schedule provides a reasonable approximation of minimum fuel burn speed with appropriate margins to initial buffet.
>
> Recommended holding speeds can be approximated by using the following guidance until more accurate speeds are obtained from the OM:
>
> - flaps up maneuver speed approximates minimum fuel burn speed and may be used at low altitudes
>
> 777-200, 777-300
>
> - above FL250, use VREF 30 + 100 knots to provide at least a 0.3 g margin to initial buffet (full maneuver capability).
>
> 777-200LR, 777-F, 777-300ER
>
> - above 10,000 feet, use VREF 30 + 120 knots to provide at least a 0.3 g margin to initial buffet (full maneuver capability).

UP Speed (Below FL200)

In smooth air, flight at UP speed is an excellent choice for pretty much all weights. Some airlines maintain a 5 knot margin as a min speed SOP above UP and all the Flap Selection speeds (*such as 5 knots above* ***5*** *during flap extension*) which comes from the classic B747 days, is consistent with setting 5 knots above VREF, and is pretty much unnecessary.

At heavy weights (*on departure*) in turbulent air – particularly during turns - 270 knots gives you a better margin above VMINM and an often wildly gesticulating VSS.

Above FL200 – all bets are off as UP speed is no longer relevant (or displayed).

In Summary

It's incumbent on the PF to select a speed that complies with ATC as much as practicable, in keeping with the safe operation of the aircraft. The speed you choose needs careful consideration anytime you're operating in turbulence or above Optimum/near Maximum Altitude – margins are reduced and while the 777-300ER doesn't lack thrust, in turbulence you might find yourself having difficulties recovering if you choose a speed too far behind the drag curve.

14.33. CPDLC Etiquette

Many of the parameters that come through the CPDLC system to crew – Altitudes, Speeds, Transponder Codes, etc – include the facility to change colour once the crew have made that selection on the flight deck (*MCP, Transponder, FMC, etc*). The conservative approach is (*where appropriate*) to make these selections and verify the "green" prior to accepting and/or actioning the change. However, there is another feature of CPDLC "green" to be employed …

CLIMB TO FL360,
REPORT LEVEL FL360
\- - - - - - - - - - - -
CLIMB TO FL360,
REPORT LEVEL FL360
ACCEPTING …
\- - - - - - - - - - - -
CLIMB TO FL360,
REPORT LEVEL FL360
ACCEPTED

The read back concept is a fundamental safety imperative of communications with ATC over voice radio communications systems.

ATC : "**Velocity One, Climb to Level 360, Report Maintaining.**"
VOZ 1 : "**Climb to Flight Level 360, Report Maintaining, Velocity One.**"
ATC : (*Nothing Further – means your Readback was received and correct*)

As shown here, there is an implicit third line in this innocuous exchange concerning a change of level. The PM has provided a read back of the level change instructions, and by receiving no further communications from ATC, the crew assume that their read back was accepted.

When you transfer this concept to the use of CPDLC, it can be seen that complete read back verification is achieved once the CPDL system annunciates "**ACCEPTED**" – only then should the PF commence compliance the ATC instruction.

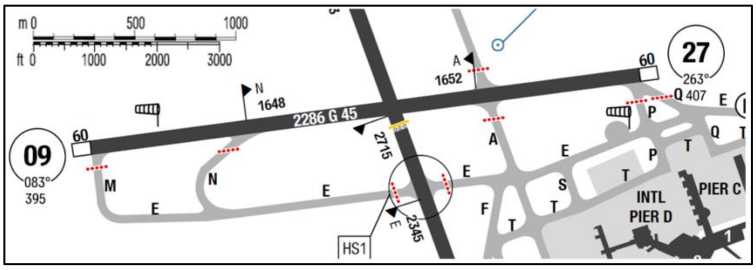
14.34. Landing Performance Assessment

The A1/SOPs require crew to assess landing performance required (LDR) against landing distance available (LDA) as part of the arrival setup/briefing. The **potential** inclusion of efficiency/cost reduction procedures such as the use of less than full landing flap and idle reverse thrust also contribute to the need for a focus on landing performance by crew.

Boeing have recommended to operators that crew perform a **Landing Performance Assessment** (LPA) for every landing when time permits. The LPA is not just an assessment of LDA vs LDR but also nominates a **runway decision point** for action to prevent runway excursions.

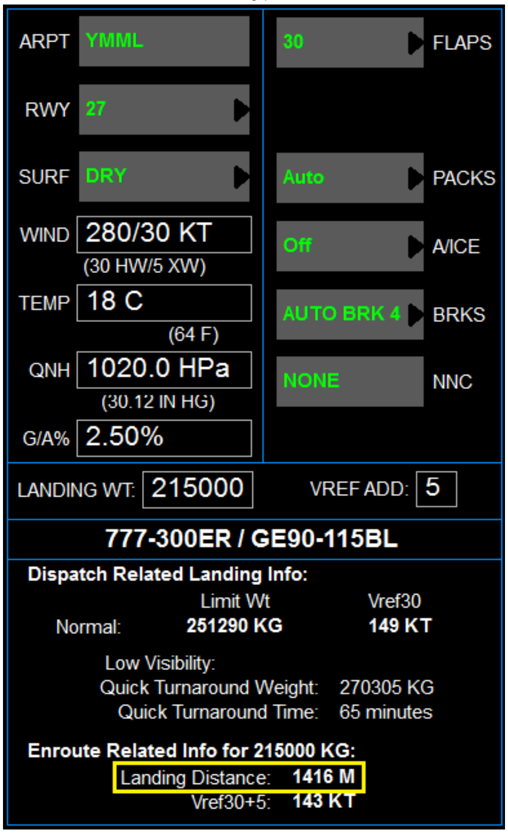
A planned runway exit point becomes a **runway decision point** as part of the LPA. If the previous assumptions concerning the landing were correct, the aircraft should be at a safe exit speed approaching the runway exit point. If the aircraft is too fast for the nominated exit – this is an indication that something may have gone wrong with the landing and immediate crew reaction may be required.

An LPA in is in essence a statement of intent given prior to the Arrival Brief, and is preceded by the following actions:



- Generate an LDR (*via TLDC, ACARS, Landing Performance Manual or QRH*) for the expected ambient conditions; use an Autobrake based on desired runway exit/taxiway and operational experience;
- Physically measure using the scale on the Jeppesen Chart from the (landing) threshold to the planned exit point and validate the Autobrake selection.
- Conduct the LPA briefing.

The LPA should include the following (*note there is no requirement to include the LPA in the CTwoPlus brief*) :



☑ Landing Flap;
☑ Autobrake Setting;
☑ Reverse Thrust Selection (*idle or max*);
☑ Runway Exit Point.

If the runway distance is limiting – this must be highlighted at the end of the LPA statement.

After touchdown, if the planned runway exit point cannot be achieved using normal (planned) deceleration, a different runway exit point should be used. If the remaining runway landing distance available is limiting – maximum braking shall be used.

In effect, in the event of a runway distance limiting scenario, the planned runway exit point becomes the **runway decision point**. Maximum braking effort should consist of full manual braking, ensuring full deployment of speed brakes and reverse thrust.

For example :

"**Landing Performance based on Flap 30, Autobrake 4, Full Reverse Thrust. With the headwind, I'm planning to exit via high speed November on the left. This runway is short, so our Runway Decision Point is November.**"

In accordance with regulatory recommendations, landing distance required as the result of an LPA for a normal landing in forecast/existing conditions should include a 15% margin.

14.35. Inflight Landing Performance

The Takeoff and Landing Performance Advisory Rulemaking Committee (TALPA ARC) recommended a number of changes to the calculation and provision of landing performance data in 2009. Just one of these recommendations includes a requirement for the Captain to assess landing distance required against landing distance available prior to approach (A1) – see **Landing Performance Assessment**. Other recommendations included:

- Increase in assumed distance from runway threshold to touchdown;
- Enroute Normal (QRH PI) distances to be factored by 15%;
- Modification of descriptors for Braking Action

The intent of these changes have been incorporated into CAO 20.7.1B.; but compliance with these new requirements – which are less conservative than using dispatch figures – is optional.

Therefore, some airlines have not yet Adopted TALPA ARC data for the 777 and as such the data represented in the QRH Performance Inflight for both Normal and Non-Normal landing may still be un-factored. Pending the acquisition and publication of TALPA ARC based landing date – we are left with two operational requirements.

Can we – Should We – Land There?

The Commander must ensure that legally and practically a safe landing can be made on the runway, based on the prevailing conditions, aircraft serviceability, NOTAMS, etc. This is accomplished using maximum manual braking distances and factoring in accordance with dispatch requirements (Dry x1.67 or Wet x1.92). On top of this check, reviewing the un-factored autobrake setting data is also valuable information when building a more wholistic, practical picture of your performance capabilities.

Where do we want to exit the runway? What Autobrake setting is that?

Having confirmed that a landing is legal and practical – good practice is to use aircraft and airport knowledge to predict a taxiway exit, determine the landing distance required by this exit, and then determine a suitable autobrake setting for landing. The nomination of this point as a **runway decision point** – beyond which a maximum stopping effort should be made – is a practice recommended by the Flight Safety Foundation.

14.36. Non Normal Landing Distance Calculation

The QRH Performance Inflight section provides raw data for the calculation of factored/unfactored (pre-TALPA ARC) landing distances required for a selection of normal and non-normal configurations. Figures are provided for Dry Runway, as well as Wet Runway *(with Good, Medium and Poor Reported Braking action)*. The (absent) Wet point is important – if the pilot in front of you reports "**Good**" braking action on a dry or damp runway – which section are you going to use?

Normal Configuration Landing Distance
Flaps 30

	LANDING DISTANCE AND ADJUSTMENTS (M)				
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%
BRAKING CONFIGURATION	250000 KG LANDING WT	PER 5000 KG ABOVE / BELOW 250000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD/ TAIL WIND	DOWN/ UP HILL

Dry Runway

MAX MANUAL	980	+25/-10	20	-40/+130	+10/-10
AUTOBRAKE MAX	1330	+25/-20	30	-55/+190	+0/0

Good Reported Braking Action

MAX MANUAL	1390	+25/-20	35	-65/+230	+35/-30
AUTOBRAKE MAX	1445	+25/-20	40	-65/+235	+30/-25

Non-Normal Configuration Landing Distance
ANTISKID (Flaps 25) VREF25
Dry Runway

MAX MANUAL	1980	35/-35	65	-105/375	85/-70
AUTOBRAKE MAX	Autobrake Inoperative				
AUTOBRAKE 2	Autobrake Inoperative				

Good Reported Braking Action

MAX MANUAL	1980	35/-35	65	-105/375	85/-70
AUTOBRAKE MAX	Autobrake Inoperative				
AUTOBRAKE 2	Autobrake Inoperative				

Non-Normal Configuration Landing Distance
FLAPS DRIVE (Flaps ≤ 5) VREF30 + 40
Dry Runway

MAX MANUAL	1260	50/-15	40	-45/190	15/-15
AUTOBRAKE MAX	1905	30/-25	50	-70/230	0/0
AUTOBRAKE 2	3290	65/-60	115	-140/465	60/-80

Good Reported Braking Action

MAX MANUAL	1815	30/-25	55	-75/260	40/-35
AUTOBRAKE MAX	1975	30/-25	55	-80/270	20/-15
AUTOBRAKE 2	3290	65/-60	115	-140/465	60/-80

These figures are fine as far as they go, but they fall down when you want to consider one of the following:

- A failure not reflected in the charts (*go look for burst tyres figures*)
- Multiple failures that impact landing performance.

There is no clear solution to the former – if you lose a few tyres during takeoff you really have no guidance and you're basically looking for a long runway to ensure safety.

But there also isn't guidance on multiple failures either. Remember – this is a Boeing and as such only one thing goes wrong at a time. Boeing don't provide data for multiple failures in combination.

The technique of choosing the worst of the two failures could be valid for some failures; but is clearly not for others.

Another technique of cumulating the two factors is likely to be more valid, but possibly overly conservative. This technique calculates the difference between normal landing distance and the first malfunction; normal landing distance and the second malfunction; adding the two resulting factors together and applying that combined factor increase the "normal" landing distance required.

Again – there is no justification from Boeing on this, and this technique also doesn't help you when one chart has you calculating ANTISKID at Flap 25, and the other chart has you calculating FLAPS DRIVE with Flaps <5 … In short – there is no right answer and it's incumbent on pilots to be aware of the limitations of the operational data provided prior to accepting a performance limited landing in a non-normal configuration.

14.37. When do you do the Recall and Notes?

It is incorrect to Recall the EICAS and review the Notes during the Normal Checklists. The ECL NM checklists are intended to be called for and completed when the items are done. The Recall and Notes are actioned in the middle of the NM Descent Checklist typically because they were forgotten by the PF during descent/approach preparation and the arrival briefing.

Descent Procedure

Start the Descent Procedure before the airplane descends below the cruise altitude for arrival at destination.

Complete the Descent Procedure by 10,000 feet MSL.

Pilot Flying	Pilot Monitoring
Review all alert messages. Review all operational notes.	Recall and review all alert messages. Recall and review all operational notes.
Verify VREF on the APPROACH REF page.	Enter VREF on the APPROACH REF page.
Set the RADIO/BARO minimums as needed for the approach.	
	Set the NAV RADIO page for the approach.
	Set the AUTOBRAKE selector to the needed brake setting.
Do the approach briefing.	
Call "DESCENT CHECKLIST."	Do the DESCENT checklist.

The ECL is a clever tool that incorporates a number of human factor/human error philosophies, allows for multi (relief) crew, failures just before landing, as well as failures that occur hours before the preparation for the approach, potentially to the relief crew. It's not perfect and is meant to assist airmanship, not replace it.

As such the function of the EICAS Recall is relatively clear. As specified in SOPs, a Recall is done with a clear EICAS message display, the Cancel/Recall switch is pressed, the word "**Recall**" is announced, and any displayed failure messages are reviewed and the implications assessed. When complete, "**Cancel**" is called for and the Cancel/Recall switch is pressed to leave a clear EICAS message display.

The ECL Notes page performs a similar function. Notes that impact on the subsequent operation of the aircraft – whether cruise, descent, approach or landing – are collected from **Completed** (*not overridden or reset*) NNM checklists for later review by the crew. Notes from multiple checklists, notes affecting crosswind limits, missed approach configuration, the availability of hydraulic services (*brakes, nose wheel steering, etc*) all collect in the ECL so that the PF will have a comprehensive list to consider when preparing for the approach.

Please note the following is moving away from specified Manufacturer or Airline SOP and into an area of personal/common technique. A suggested way of incorporating the Recall / Notes ECL NM Checklist item into Normal Operation is as follows.

Approach Preparation

As part of preparing for the approach, the PF should begin with a **Recall**, read and **Cancel** the EICAS with or without the involvement of the PM (*ideally with*). PF should then move into the ECL Notes page and assess the impact of those notes on the approach and landing to be flown. Note that even if the Recall was clear there can still be Notes from NNM checklists that completed with the originating failure alert no longer on EICAS.

In extreme cases, Notes can dictate runway, approach or even airport selection. As such, beginning your approach preparation with the Recall and Notes can save significant time later. This technique follows the CRM methodology of allowing for NNM operation during NM operation through the incorporation of good habits. If you run the Recall and check for Notes during the preparation for every normal approach, you will pick them up when preparing for an approach after a NNM event.

When the ECL Notes Page is complete, leaving the Descent Checklist displayed (*which will come up when you press the ECL switch to display the Notes prompt*) as a reminder to both do the checklist later, as well as incorporate the Autobrake and Landing Data in your approach preparation.

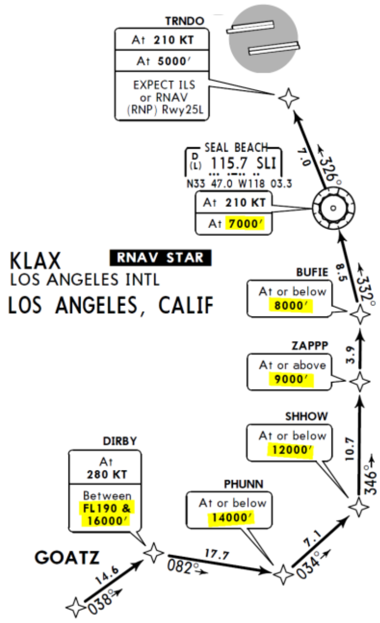
Arrival Briefing

When the setup is complete and the PM has checked the FMC and organised that side of the flight deck, the Approach Briefing can begin. Since the preparation for the arrival was best commenced with the Recall and Notes – the Arrival Briefing can also begin quite effectively the same way. If the PM wasn't involved with the previous review – run the Recall, read the messages, accept the Cancel instruction and clear the EICAS, and move onto the Notes.

Personally I commence an Arrival Briefing by copying the Descent Checklist : "**Ready for a Brief? Ok – Recall** (*messages read, Cancel EICAS if necessary*); **Notes** (*no Notes, leave the Descent Checklist displayed*); **Autobrake 3**, **Flap 30 Vref 145 knots**, **Minima 640 ft Baro**" ... And then on with the **Approach Briefing … Completed**.

Briefing Complete? -> Run the **Descent Checklist** already displayed on the lower MFD.

14.38. STAR (& SID) Altitude Restrictions & MCP Altitude Selections



In some countries when you're issued with a descent clearance, the implied (*or explicit*) paradigm is that you may descend to that altitude without the promulgated restrictions of the previously cleared STAR (or SID).

However, an alternative procedure is for ATC to clear you to climb/descend via a SID/STAR either without stating the final level (*this is provided on the chart*); or a specific clearance limit will be given "**Velocity Two, Descend via the BUFIE1 STAR, not below 8000 ft.**"

The challenge for this second scenario is two-fold. Firstly, these SIDs and (especially) STARs include multiple Above/At/Below/Between altitude constraints, often combined with speed restrictions that must be carefully monitored and complied with, increasing the cognitive burden and overall workload on the crew.

The second issue depends on the MCP Altitude Setting procedure in use. The **standard** Boeing procedure is to set all binding at/above (STAR) and at/below (SID) constraints in the MCP until compliance is assured, and then set the next restriction. This process continues until the final SID/STAR altitude/level has been set – or the intermediate ATC Clearance Limit. In the latter case – for much of the procedure the ATC provided Clearance Limit is not set and the crew must remember that they are limited to the ATC instructed 8,000 ft – not 7,000 ft as documented in the STAR (*shown here*). **The risk here is the crew violating a clearance limit proscribed by ATC**.

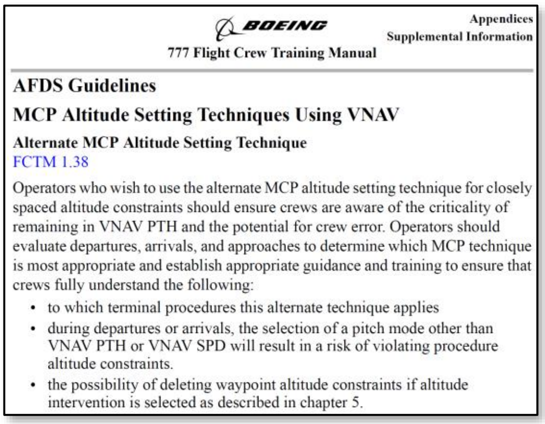
Offsetting mitigators include writing down/recording the clearance limit, and consistently referring to this limit at each reset of the MCP Altitude Selector "**We are Ok for 16,000 at DIRBY, setting 9,000 for ZAPP, we are cleared to 8000 ft.**" Additionally, this procedure does nothing to reduce the workload associated with a complicated SID/STAR where the MCP Altitude Selector is constantly reset despite the demonstrated capability of VNAV to fly the procedure as programmed.

Additional techniques for keeping track of the clearance limit include the following, none of which actually stop the aircraft breaking the clearance limit.

- Writing down the Clearance Limit (*2nd Observer should also be recording this on the CFP*).
- Storing the clearance limit in the Scratchpad. This typically works best for the PF, since the PM is likely to need the scratchpad for changes during the STAR;
- Storing the clearance limit in the FIX page altitude. Once the altitude is met, the fix page reference disappears – but typically by that point it's either already served its usefulness – or you missed it and it's too late anyway.

Alternate MCP Altitude Setting Technique

However, when the Operator has decided to train and implement the **Alternate MCP Altitude Setting Technique – Climb, Cruise, Descent**, the crew may set the STAR end Altitude or ATC Clearance Limit (*in this case ATC 8000 ft*) and thereafter rely on VNAV to meet the constraints during the descent. There are at least a couple of risks associated with this technique.


BOEING
777 Flight Crew Training Manual
Appendices
Supplemental Information

AFDS Guidelines

MCP Altitude Setting Techniques Using VNAV

Alternate MCP Altitude Setting Technique

FCTM 1.38

Operators who wish to use the alternate MCP altitude setting technique for closely spaced altitude constraints should ensure crews are aware of the criticality of remaining in VNAV PTH and the potential for crew error. Operators should evaluate departures, arrivals, and approaches to determine which MCP technique is most appropriate and establish appropriate guidance and training to ensure that crews fully understand the following:

- to which terminal procedures this alternate technique applies
- during departures or arrivals, the selection of a pitch mode other than VNAV PTH or VNAV SPD will result in a risk of violating procedure altitude constraints.
- the possibility of deleting waypoint altitude constraints if altitude intervention is selected as described in chapter 5.

- There have numerous instances in the past where a SIDs/STARs have been published in the FMC with missing speed/altitude constraints. While crew are required to verify the FMC against the Jeppesen chart, this publications omission has regularly resulted in SID/STAR violations because the missing constraint was not identified; or the SID/STAR was subsequently re-entered after the initial check and the requirement to check/amend the FMC was not repeated.
- With the MCP Altitude Selector set to the cleared ATC limit and multiple SID/STAR altitude restrictions set in between; each push of the altitude selector should delete the next active speed/altitude constraint, without the need to execute the modification. This deletion often results in a short period of **THR … VNAV SPD** ; then back to **IDLE/SPD … VNAV PTH** but not always. As a consequence, it's easy for the crew to delete a LEGS page altitude constraint when they are unprotected by the MCP Altitude Selector. An additional minor consideration is that this technique can result in complacency where the crew become overly reliant on VNAV to assure compliance without remaining "in the loop" of the AFDS and the aircraft flightpath.

Mitigators against these risks include strict compliance with SOPs for setting up/checking/briefing procedures; and heightened awareness and monitoring of SID/STAR altitude/speed compliance during the climb/descent.

14.39. Runway Change on Arrival

Runway Change - Arrival

ATIS & ATC Clearance
- QNH in particular should be checked

NOTAMS / Jep 10-7 - Review

FMC Change
- **DEP ARR** : Rwy/Apch -> STAR/Transition
- **LEGS** : STAR/Transition/Apch Speeds/Altitudes; MAP
- **FIX** : MSA/LSALT, etc.
- **NAV RAD** : Aids for the Arrival/Approach/MAP
- PF/PM Crosscheck?

Landing Performance
- Landing Performance Assessment – Runway Exit
- Flap / Autobrake Setting
- VREF Setting

Arrival/Approach Briefing
- Update (PM can quick-brief the PF)

Descent Checklist
- Recall/Notes/Vref/Minima – Further Implications?

Much like **Runway Change on Departure** – changing your Landing Runway (*Airport, Instrument Approach, and/or STAR/Transition*) during the descent after all your carefully planned, setup and briefed actions, based on what now turns out to be the wrong runway – can be a **High Risk Event** that brings with it significant Threat and opportunity for Error.

As before – a quick reference guide like the one shown here can be used as a mitigator against this thing going pear shaped – but is not a replacement for Airmanship and careful, thoughtful execution.

Unlike cruise – the descent environment is one where the Pilot Flying needs to fully focus on flying the aircraft and controlling flightpath; even as the Pilot Monitoring becomes totally distracted by the requirement to consider and establish the changes required.

This is one of the few times where out flight tends necessarily towards a single pilot operation – I'm not endorsing this aspect; I'm just saying that this is what happens. So - recognise the threat and deal with it accordingly. During this time if the aircraft suffers flightpath changes from ATC; or changes are require to comply with procedural restrictions – the PM should stop and return fully to the Pilot Monitoring role, before getting back on with setting up for the new runway.

Handing over so the PF can do the setup remains an option but handing the aircraft back and forth come with it's own risks. Maintaining the mental model of situational awareness that is arrival/descent is something both pilots should be doing – but by it's nature it tends to be something the PF is able to hang onto best if he/she remains the PF.

DESCENT CHECKLIST

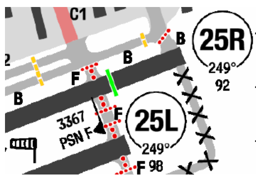
Recall	Checked	PF
Notes	Checked	PF
Autobrake	___	PF
Landing data	VREF ___, Minimums ___	PF
Approach briefing	Completed	PF

The Descent Checklist is an interesting one. Anytime you suffer a runway/approach change – or in fact if you divert to your alternate – the Descent checklist should be either re-run or at least it's requirements considered in the procedural handling of the change.

Route 2 Usage

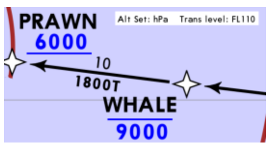
In the context of a runway change, Route 2 allows you to pre-build an alternative STAR/Transition/Approach and Missed Approach – to be activated when a runway change becomes evident. When activating Route 2 – you'll need Activate Route 2; find the next waypoint relevant to your revised clearance, go direct to that waypoint and "**Confirm** … **Execute**". Both pilot should give the new active route a check/crosscheck even if they validated Route 2 during Arrival preparations.

14.40. Parallel Runway Awareness



Vectoring for final at airports with closely spaced parallel runways requires extra vigilance by crew. Overshoots of the centreline may or may not be accounted for by ATC – Crew should endeavour to avoid straying across the centreline into the approach of the parallel runway if possible. Note the use of LNAV to intercept final can be useful in this regard - see **LNAV into Localiser Capture**.

14.41. Descent into Lower QNH's through Transition



The B777 FMC does not account for changes between Standard and Area/Airport QNH in its calculation of the VNAV descent path. The most obvious result is an (*at times*) radical change in descent rate after the QNH is set at Transition Level on descent. As long as there are no altitude constraints at/shortly after transition, this is an expected (*annoying*) behaviour – but without consequence.

Otherwise – going transition early can resolve any potential problems before they occur, allowing VNAV more time to sort out the path change required. An alternative is to modify the troublesome altitude constraint, giving VNAV a margin to work with – such as 8800B against WHALE in the example shown here.

15. Holding, Approach & Landing

CAUTION

This document conforms to the FCTM guidance of MCP Altitude Setting. This means, principally, setting all of the altitude constraints relevant to flightpath/procedure/clearance – unless specifically released from this burden by the clearly defined Alternate MCP Altitude Setting technique in **VNAV PTH**.

Some airlines expand this technique to include the entire SID or STAR irrespective of the recommendations of the FCTM; and some airlines extend this paradigm down into the Non Precision Approach – both Managed (VNAV) and Basic Modes. Accident and Incident data shows us that leads to a significantly increased probability of terrain compromise and altitude clearance violations. This guidance is reflected specifically in the following sections.

- Alternate MCP Altitude Setting Technique – Climb, Cruise, Descent
- Alternate MCP Altitude Setting Technique – VNAV NPA
- Basic Modes Non-Precision Approach

You will of course do what your airline Training/Standards department requires.

15.1. LNAV / VNAV Approach Validation

Before an LNAV/VNAV approach can be flown, it should be validated by the crew. Typically, this is done as part of the pre-arrival briefing preparation. The Boeing FCTM lists the basic rules required before using LNAV/VNAV in approach mode.

The following are common errors when reviewing the LEGS page in preparation for an LNAV/VNAV NPA approach

- Insertion of extra waypoints in the LEGS page.
- Alteration of altitudes at or after the FAF
- Missing the requirement to cycle the Flight Directors at the minima (see **Flt Director OFF at Minima?**)

The insertion of additional waypoints in the LEGS page can disrupt the approach logic of VNAV, along with Nav Rad auto tuning.

The alteration of altitude constraints in the LEGS page should be restricted to that necessary to compensate for cold temperature environments. See **Cold Temperature Corrections.**

* Note that while this validation criteria suggests a Jeppesen/FMC track check of ± 1°, it's theoretically possible to have larger differences (to a maximum of ± 3°) owing to differences between Jeppesen/FMC variation and magnetic/true track calculation logic. Charts with a final course outside ± 1° should be treated with caution but can be flown in LNAV/VNAV if they otherwise validate.

LNAV / VNAV Approach Validation

- Database selected Approach (*Overlay Approaches are not approved under PBN*)
- Final Track on LEGS Page should match Jepp ± 1° (3°)*
- Distance FAF to Rwy/MAP should match Jepp ± 1nm
- No minimum constraint altitudes infringed
- FMC Approach GP angle should be greater or equal to Jepp published GP (*2.99° notwithstanding*)
- The altitude at the MAP or the RWY waypoint should be appropriate for a straight in approach
- Approach Pre-Set RNP/ANP Check (as charted; or 0.3 GPS/GNSS; VOR 0.5; NDB 0.6; RNAV 0.5)
- No Vertical/Lateral adjustments from FAF onwards
  - Speed changes are acceptable
  - Altitude changes IAW cold temp corrections ok
- The FMC approach design must be one of:
  - Approach with Published Glidepath (GP); or
  - Approach must have a RWxx waypoint coincident with the approach end of the runway; or
  - Approach must have a Missed Approach (MAP) waypoint prior to the approach end of the runway.

The crew should also take note of the waypoint after which the FMC LEGS page includes a published glidepath angle – prior to this the MCP altitude selector may have to be set and the aircraft will follow the more traditional VNAV descent path, rather than an approach glideslope. See **Alternate MCP Altitude Setting Technique – VNAV NPA**

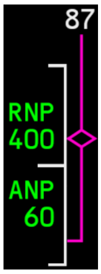
Note that all approved RNAV approaches are validated with respect to WGS-84 airspace and there is no requirement to disable GPS updating.

15.2. Setting DH/MDA for Cat IIIB No DH Approaches

Some crew set 0 (zero) as the DH for a Cat IIIB No DH Approach. This is technically incorrect and reduces the effectiveness of the DH/MDA selector for these approaches.

In fact, this approach has **No Decision Height**. As such the Minima MDA/Selector should be set to DH, the Cat IIIA DH set and the DH hidden from view – No DH. In the event of a reversion to Cat IIIA (Land2, Auto throttle Failure, etc) – the minima selector can be pressed and the Cat IIIA DH will appear. Note that the MDA can be set to the Cat I minima as well.

15.3. VNAV Approach – No Path Indicator



Prior to commencing a VNAV approach, a quick look at the ND to verify the existence of the VNAV Descent Path Indicator and the position of the aircraft relative to the commanded path can save some significant embarrassment at the IAF - if the Path Deviation indicator is not displayed, the likelihood is that VNAV PTH will not engage or will not commence a descent at the IAF.

Typically, the ND Path Deviation Indicator fails to display when the FMC is in VNAV Climb or Cruise mode (*select VNAC on the FMC CDU to check*). This most commonly occurs in the case of diversions during climbs or when returning to the departure aerodrome. There are two ways to correct this situation.

One method is to insert the current altitude into the VNAV CRZ page. This will force the FMC from CLB to CRZ mode. As the aircraft approaches top of descent (*which may well be the IAF*), the FMC will transition into FMC Descent mode and the path deviation indicator will display. However this all happens very late – moreover the FMC will not accept a cruise level that is at or below an altitude restriction in the LEGS page. It deals with this anomaly by deleting all LEGS page constraints that are at or above the entered cruise altitude. More often than not, this is the altitude at the IAF and if it goes un-noticed the VNAV Path will no longer comply with the IAF charted restriction. Whoops.

A better method is to use the DES NOW> prompt on the CDU VNAV DESC page, without deleting any constraints. This forces the FMC into descent mode and immediately displays the ND path deviation indicator.

Awareness of the aircraft's position relative to the programmed descent path prior to final approach is crucial to successful VNAV PTH engagement.

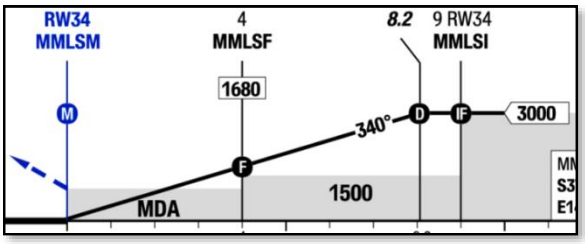
15.4. How slippery is the 777?

Pilots new to a type often take a while learning the descent and speed reduction profiles of their new home. Some figures to help you along. With the Autopilot engaged, it takes …

- 10 nm : From 320 KIAS to Flap 5, Flap 5 Speed at Max Landing Weight, Idle Thrust, Level Flight at 3000 ft.
- 22 nm & 4500 ft : From 320 KIAS to Flap 5, Flap 5 Speed at Max Landing Weight, on Descent in FLCH SPD (80/20 Rule).

At Flap 5, Flap 5 speed you're set to hit the glideslope and descend either in configuration or with Gear Down/Flap 20.

15.5. VNAV Approach – Early Descent



Leading on from LNAV / VNAV Approach Validation is the often miss-understood early **VNAV Descent**. This occurs when a waypoint exists on the published approach that is not in the LEGS page.

In the example given, the FMC LEGS page includes **MMLSI** (**3000**), **MMLSF** (**1680**) and **MMLSM** (**0480**) waypoints, with appropriate altitudes at each – note the altitude at MMLSM is the expected altitude as the threshold is crossed (TCA+50 ft)

The published LEGS page glide path angle for this approach is 3° (2.99°) and commences from MMLSF – the FAF. As such prior to this point the FMC commands VNAV to follow the traditional fixed point to fixed point path. The result of this is that VNAV will commence the initial descent at MMLSI and will not wait for the 8.2 fix in order to establish 3°.

The Flight Safety Foundation Approach & Landing Accident Reduction program (ALAR) and general industry recommendations are for a stable 3° descent from the initial approach altitude. While technically not in compliance, this VNAV behaviour is considered acceptable, at least until the relevant VNAV approaches are re-coded with approach slope angles from the IAF. As long as VNAV keeps the aircraft above 1500 ft until the FAF (*in this case, 1680 is what VNAV is aiming for*) the best method is to stay hands off and monitor VNAV down the approach. Briefing the event as part of your arrival briefing is not a bad idea.

15.6. ATC & Speed Control

ATC Speed control is heavily utilised for traffic separation at major international airports. When it's done well – such as in LAX – it usually negates a requirement to hold. It may not seem terribly efficient to be doing 250 knots from 26000 ft – but it's usually more efficient than having to hold. The following references are taken from the Air Traffic Control Handbook (JO 7110.65V).

- When you're taken off a STAR by ATC, previously assigned or published speed restrictions should be re-iterated by ATC.
- When you're "**Cleared for Approach**", you are released from previously advised speed restrictions, unless they are re-iterated by ATC as part of your approach clearance.
- When in doubt … Ask!

15.7. Alternate MCP Altitude Setting Technique – Climb, Cruise, Descent

The Boeing FCTM requires the setting of all altitude constraints (*whether from ATC or a SID, STAR, Approach*) in the MCP Altitude Selector during Climb and Descent, irrespective of the use of VNAV or Basic Modes (FLCH/VS/FPA).

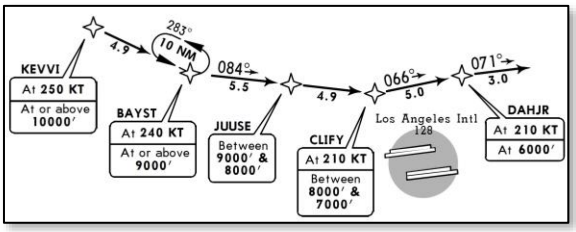
This requirement is relaxed somewhat when VNAV SPD/PATH is used, the required path is protected by validated altitude constraints in the LEGS page, **and the altitude restrictions are closely spaced**. In this circumstance the Alternate MCP Altitude Setting Technique may be used.

> **FCTM 1.37 Alternate MCP Altitude Setting Technique**
> - For departures, set the highest of the closely-spaced constraints.
> - For arrivals, initially set the lowest of the closely spaced altitude constraints or the FAF altitude, whichever is higher.
>
> **Note** : The Operator must approve the technique and crew must be appropriately trained. Additionally, this technique may also be used for Tailored Arrivals (TA) regardless of how closely the altitude constraints are spaced.

- During Climb and during Descent between Top of Descent and the Initial Approach Fix (IAF) if "***waypoints with altitude constraints are closely spaced to the extent that crew workload is adversely affected and unwanted level-offs are a concern***" the **Alternate MCP Altitude Setting Technique** may be used – but only after appropriate training has been provided by the Operator, which should include nominating the SIDs and STARs (*including segments*) the Technique may be used for.

SID and STAR Usage

The Alternate MCP Altitude Setting Technique may be used for those segments of SIDs and STARs where waypoints with altitude constraints are closely spaced (*in terms of crew workload*). This requires Operator Training to crew and should include the nomination of which SIDs/STARs (*and by inference the sections of those procedures*) the Technique may be used for.



The primary risk associated with this technique is the ability for the PF to clear intervening altitude restrictions from the LEGS page with inadvertent (*or advertent*) presses of the MCP Altitude Setter knob – possibly with little or no notification to crew of the change in the LEGS page. Close monitoring of the LEGS page vs the published procedure is required to ensure this does not take place.

STARs & VNAV Path Protection : At-Or-Below

When in VNAV, descending to an MCP Altitude Setting that is below an intervening LEGS page At-Or-Below altitude restriction (eg: *Descending to 9,000 ft, with 12000B at the next waypoint, and 9000 set in the MCP Altitude Setting window*) – there is a measure of VNAV Path protection. As long as you are in **VNAV PTH** you are reasonably assured of meeting the restriction. But if ATC require speed intervention (**VNAV SPD**) or you get High/Low path condition and revert to **VNAV SPD** - then this assurance is compromised. As you approach the waypoint, if you are unlikely to meet the restriction, the FMC provides no warning that the requirement is not going to be met (**UNABLE NEXT ALTITUDE** *is a climbing message*) unless you are deviating above the path in which case **DRAG REQUIRED** might occur. Either way flight crew intervention will be required – Speedbrake.

STARs & VNAV Path Protection : At-Or-Above

At-Or-Above's are handled slightly differently. Again, the scenario is descending to 9,000 ft with 9,000 ft set in the MCP Altitude Window, but a waypoint ahead with 10000A. Once again – if you're in **VNAV PTH** you are reasonably assured of meeting that restriction (*unless you press the Altitude Selector*). But if you are in **VNAV SPD** compliance is not technically assured. In this instance, as you approach 10,000 ft and look like breaking the restriction, the AFDS will re-engage **VNAV PTH** - ***keeping the speed window open*** – and level off to meet the restriction. After this, the AFDS will revert to **VNAV SPD** and continue the descent

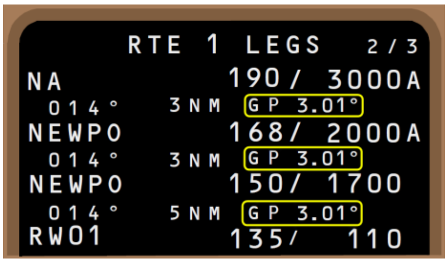
Setting MCP AT-Or Below's on Descent / At-Or-Above's on Departure

While Boeing are quite focussed on protecting all altitude constraints, there is some relief in VNAV from protecting At-Or-Above constraints on climb and At-Or-Below constraints on descent. The non-setting of such constraints during climb/descent is ubiquitous across most airlines.

Irrespective of this procedural relief – anytime you are intending to meet a restriction that is not currently set in the MCP Altitude Window – maintain a heightened situational awareness of your vertical flightpath to ensure compliance with the restriction.

> 777 Flight Crew Training Manual
>
> **Descent Constraints**
>
> Descent constraints may be automatically entered in the route when selecting an arrival procedure, or manually entered through the CDU.
>
> Normally, set all mandatory altitude restrictions and "at or above" constraints in the MCP altitude window. The next altitude may be set when the restriction has been assured or further clearance has been received. This procedure provides altitude alerting and ensures compliance with altitude clearance limits.
>
> For descents in pitch modes other than VNAV PTH or VNAV SPD, the MCP altitude must be set at the next altitude constraint, or as published in the FCOM for an instrument approach.
>
> FCT 777 (TM) 4.19

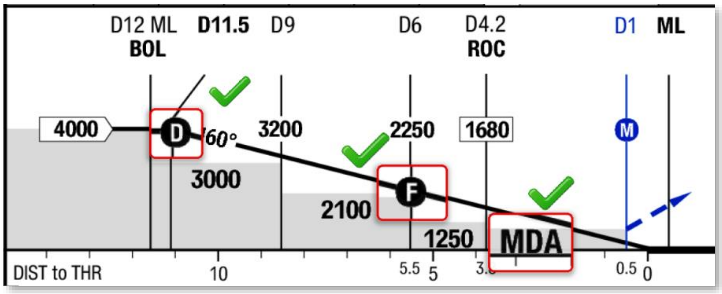
15.8. Alternate MCP Altitude Setting Technique – VNAV NPA



Specifically, for VNAV NPA's, this technique can be used with **VNAV PTH** engaged, coupled to a validated set of FMC LEGS page altitude restrictions with a published glide path. Refer to the FCTM and **LNAV / VNAV Approach Validation** for approach validation.

From the IAF or platform altitude onwards the MDA may be set as long as VNAV is guided by a glide path angle on the legs page.

In the CDU example given here, the MDA may be set once the aircraft approaches the position **NA**, since there's a published (validated) LEGS page glidepath from this waypoint to the runway (MAP). In this case, neither the FAF nor any intervening altitudes need to be set.



Many approaches incorporate a LEGS page glidepath from the FAF only - in the plan diagram shown the LEGS page has a glide path from the **D6** waypoint.

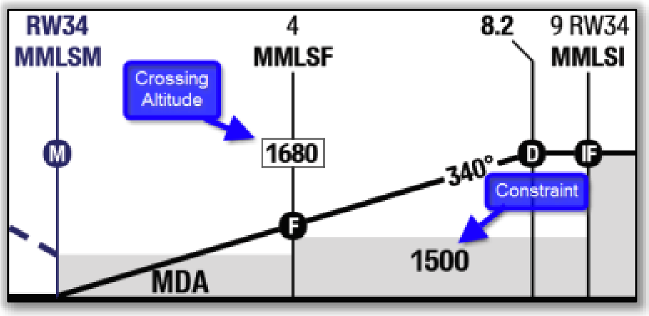
As such in this instance (*coded angle from FAF/D6*) …

- Altitude constraints between the Initial Approach Fix (**IAF**) or platform altitude and the Final Approach Fix (**FAF**) that are "*closely spaced to the extent that crew workload is adversely affected and unwanted level-offs are a concern*" do not need to be set.
- Altitude constraints between the **FAF** and the Missed Approach Point (**MAP**) are not set where a published Glide Path (GP) angle is present on the LEGS page.

As long as the LEGS page validates and there's a published glide path angle from at least the FAF -> MAP, the PF is required to set the **IAF**, the **FAF** and then the **Minima**.

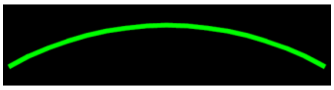
While IAF → FAF Intermediate altitudes may not have to be set by the PF – all care should be taken to ensure no intermediate altitudes are compromised – or captured.

Setting Crossing vs Constraint Altitudes and Rounding



NPAs are based on a glidepath angle that assures terrain clearance and usually results in check/crossing altitudes in excess of any minimum constraints published on Jeppesen charts. The FCOM/FCTM NPA procedures generally document the requirement to set approach **constraints** which means the lower altitudes (constraint, rather than the crossing altitude).

However, the FCTM offers the option of setting step down fix altitudes (when higher than the associated constraint) for Basic Modes NPA's where the pilot wishes to use the altitude range arc can choose to use crossing rather than constraint altitudes.



If the crossing or constraint altitude to be set is not a multiple of 100 – FCOM advises setting the next lowest 100 for the crossing/constraints (round down); and the next highest 100 for approach minimums (round up).

Personally – I set the **constraint** (*1500 in the diagram above*). This means that the altitude range arc works on the lowest altitude that I would want to be at the associated waypoint, and will typically show after the waypoint on the legs page.

This doesn't necessarily tell me whether I will be high or low at that waypoint – but as long as the range arc is after the waypoint – I'm clear of terrain. And I tend to capture the MCP Altitude Selector less often …

Setting Altitude Constraints that are NOT in the LEGS Page

Typically on a **VNAV PTH** approach, compliance with charted approach constraints that are not in the CDU LEGS page is implied – but must be monitored. However, on Basic Modes approaches, often these waypoints need to be constructed using the CDU FIX page to provide a visual point for intermediate MCP Altitude step downs. Again, the use of the "green banana" is not the point here (*although at a constant rate of descent it can provide decent information*) – it's using the MCP Altitude Selector to protect the aircraft from descent below the step-down fix altitude until at the appropriate point.

15.9. Basic Modes Non-Precision Approach

Genuine Basic Modes (*Non VNAV or Non LNAV-VNAV*) NPAs are something of a rarity in the 777 operation; usually confined to isolated corners of the regulatory simulator training matrix. Typically, the "Basic Modes" or "LNAV Only" approach requirement is meant to provide 2D instrument approach recency (*familiarity*) as part of the recurrent matrix.

It depends on where you look, but to generalise - a 2D approach is one where an electronic glideslope (*either broadcast up from the ground or calculated by the FMC*) is not required (*vs available*), and it may be up to the pilot to get the aircraft on the right glidepath and keep it there to the MDA/DH, using the mark one calculating engine (*your brain*).

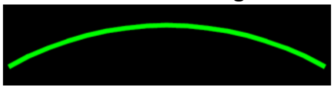
While the training focus is usually on the vertical path compliance and often LNAV is available for lateral tracking – those of us who've had to do it without both LNAV and VNAV for some reason are quite familiar with the workload that results. The use of **TRK SEL** helps somewhat, but you only really appreciate the true value of **LNAV** during those times when it's not available to you.

While many of us have finally become familiar with FPA – for those new to the aircraft the recommended technique is to use VS to establish the required glidepath – and as soon as you think you're on slope, switch across to FPA and set 3° to produce a lower workload solution to the basic modes approach. The issues with FPA initially tend to revolve around a lack of appreciation of the subtly of the mode, where the difference between 3° and 3.1° can be less than 30 ft/min.

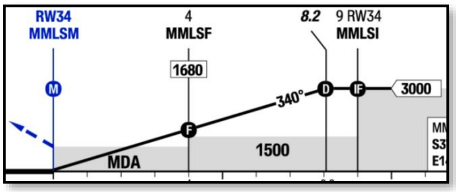
Note to self – if you're using FPA and you get high – wind in a decent change (3.5° or more) to the FPA setting to get the proper rate of descent for recovery to path. Note also that low temperatures require a slightly lower descent angle (and vice versa) – see ***Cold Temperature Corrections.***

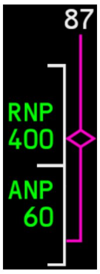
Assuming you've fully digested the method of using VNAV for a Non-Precision Approach – the FCTM documents a number of changes in the basic procedures for non VNAV NPAs, summarised as follows:

- **All Altitudes must be set in the MCP Altitude Selector**, including the IAF, FAF, MDA, published waypoint/fix constraints after the LEGS page coded approach angle, and "closely spaced" altitudes. All of them, without relief. Have fun with that.
- This includes charted constraints that are not in the LEGS page : **Setting Altitude Constraints that are NOT in the LEGS Page**
- The Flight Directors must both be cycled OFF and the PM F/D returned ON by "leaving the Minima" if you are continuing down to the runway. The FMC may have a valid path to the threshold/TCH – but the Flight Directors are not following it.
- The FCTM provides the option of setting "crossing" altitudes rather than "constraints" to improve the ability of path prediction using the Altitude Range Arc. This also increases the likelihood of unwanted altitude captures, but you can't have it both ways …



If your instructor has left you with a valid LEGS page glidepath, then slaving your VS/FPA inputs to maintaining the ND Vertical Deviation Indicator usually gives you a pretty good approach – just throw in the odd distance/altitude fix so everyone knows you're situationally aware.





But remember to check that the FMC LEGS page path matches the Approach Chart (*you'd be surprised how often it does not* – **VNAV Approach – Early Descent**) – and decide how you're going to handle any differences. Are you going to follow the VNAV Path, or are you going to follow the published approach - brief it.

In any event – the PM should be calling the relevant crossing altitudes to assist the PF in situational awareness and appropriate MCP Altitude setting. This can consist of the Waypoints/Fix Altitudes and/or any published distance/altitude tables on the approach chart. Many airlines publish a set of standard calls to provide a structured framework for these callouts.

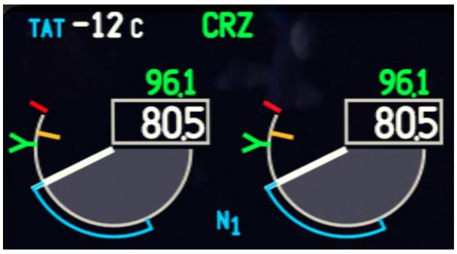
Experience has shown that calling all the DME/Fix altitudes leads to an overloaded PM and a verbose flight deck. It might be worth discussing during the briefing some specific points to call, especially in the event the approach is going well and on slope. A verbally busy flight deck tents to lead to unwanted ALT captures, which are harder to recover from during basic modes.

PM : " **9 miles, On Slope** "	PM : " **9 miles, 150 High/Low** "	PM : " **3 miles ANNIE, On Slope** "
PF : " **Checked** "	PF : " **Checked** "	PF : " **Checked** "
PM : " **Next 8 miles 1840** "	PM : " **Next, 8 miles 1840** "	PM : " **Next, 2 miles ANNIE, 1870** "
PF : " **Checked** "	PF : " **Checked** "	PF : " **Checked** "

BN DME	11.6	11.0	10.0	9.0	8.0	7.0	6.0	5.0	4.0
ALTITUDE	3000′	2820′	2500′	2160′	1840′	1510′	1190′	870′	570′

NM to NEXT WPT	1.6	1.0	BBNSI	3.0	2.0	1.0	ANNIE	3.0	2.0	1.1	BBNSM
ALTITUDE	3000′	2830′	2510′	2190′	1870′	1550′	1230′	1170′	850′	560′	

15.10. Boeing Thrust Reference Setting Anomaly



There is a bug in the Thrust Reference setting software in the 777. While this bug manifests itself in several situations on normal and non-normal operations, it manifests significantly with some flight safety implications during VNAV engine out approaches.

Boeing's airplane design is such that GA is set as the thrust limit (*displayed above the N1 indication*) any time the flaps are extended (*FCOM Ch 04 refers*) or the glide slope is captured. One assumes that Boeing's intent was that GA should remain the thrust limit to either Landing or the Go-Around in order to provide maximum available thrust for manoeuvring while configured for landing. However, **when VNAV is engaged** after flaps have been extended, **the Thrust Limit is reset to CRZ** and the Autothrottle will be limited to this thrust limit until it is changed. In most normal situations this reduced thrust limit is adequate to preserve airspeed irrespective of configuration (*Engine Out, Gear, Flap*) – particularly in the 777-300ER. But 777's with less thrust such as the -300/-200, or in performance limiting situations such as weight in excess of MALW, high density altitudes, etc – insufficient thrust can exist to maintain airspeed/altitude.

Prior to a low speed excursion, stick shaker activation and AP stall protection, the problem can be corrected by :

- Selecting GA through the FMC Thrust Lim page;
- Pressing the CLB/CON switch (only CLB/CON thrust limit will be selected, not GA);
- Simply pushing the thrust levers forward (an A/Thr Disconnect for Manual Thrust is probably the better suggestion).

CON thrust should be enough to maintain speed at maximum landing weight, but higher weights may require even more thrust.

Scenario Description

Assume a 777 at maximum landing weight, approaching the final approach fix (FAF) at platform altitude for an Engine Out NPA. The crew intend to use VNAV for the approach but have manoeuvred to the initial approach altitude using Basic Modes (FLCH / VS). Configured correctly at Flap 5/Flap 5 Speed, thrust reference would have become GA with Flap extension – but if FLCH/VS was engaged after Flap extension it will be CON. Any of these (GA/CON/CLB) should provide adequate thrust.

At 3 nm from the FAF, Gear Down/Flaps 20/Flap 20 speed is selected. Thrust levers retard to slow the aircraft to Flaps 20 speed. Meanwhile the PF will set the minima in the altitude select window on the MCP, check track, engage VNAV PTH and speed intervene.

With the engagement of VNAV, CRZ thrust limit reference is set – unnoticed by the crew. As the aircraft approaches Flap 20 speed, thrust levers advance in anticipation to achieve speed stability (*giving the PF the tactile feedback expected of thrust maintaining speed*), but thrust is now limited by CRZ thrust. Often Engine Out the combination of maximum landing weight and/or high-density altitude, CRZ thrust is insufficient to maintain speed, but often enough to preclude a negative speed trend indication. Speed will now continue to reduce until (a) descent for the approach commences, (b) an increase in thrust and/or thrust limit is set; or (c) stick shaker/stall protection. I have seen this time and time again.

Speed Protection? At minimum manoeuvring speed, low speed protection would normally kick in (*minimum AFDS speed or eventually auto throttle wakeup*), but in this case this protective feature is limited by the CRZ thrust limit setting. The only low speed protection that will function (*through the autopilot*) is stall protection - as the aircraft approaches stick shaker speed, it will pitch forward and descend with failed FMA AFDS mode indications, at low altitude, in Landing Configuration. Not nice.

Prior to a low speed excursion and stick shaker activation, the problem can be corrected by selecting GA through the FMC Thrust Lim page or pressing the CLB/CON switch (*CON thrust limit only will be selected*) – ***or simply pushing the thrust levers forward*** – whether disconnecting the A/THR first or not. CON thrust should be enough to maintain speed at maximum landing weight. Higher weights may require more thrust.

Additionally ...

- On all precision approaches (*after Flap selection*), FLCH may set CLB/CON, but glide slope intercept will reset to TO/GA.
- TO/GA switch FMA mode activation sets GA thrust, so GA thrust limit is set during all go-arounds.
- Flap extension beyond 22.5° sets GA thrust limit (*Note-To-Self about Flap 20 Landings …*)
- This anomaly does not impact on other NNM procedures (*such as Windshear, GPWS, TCAS RA*). These recalls require either TO/GA Switch activation and/or manual thrust.

15.11. Flap Extension

During approach crew should ideally not extend flap to the next selection until approaching (*within 20 knots*) the minimum speed for the existing flap. Early flap extension results in unnecessary wear and tear on the flaps. On some Boeing types (*notably the B747-400*) there are Boeing and Company specific recommendations against the use of Speedbrake with any Flaps extended. The 777 FCTM recommends against significant Speedbrake extension with Flaps in excess of Flap 5 (*due turbulence over the horizontal stabiliser*). Other than this, Speedbrake is very much preferred over Flaps as a means of increasing drag on the aircraft when fast/high on descent/approach. Appropriate Flap Selection and prompt (automatic) speed reduction should result in less wear and tear on the flaps as well as avoiding the up and down cycling of the thrust levers.

It is not standard for crew to skip standard flap settings during extension (*other than F15/F25*) and generally an indication of a poorly planned/managed initial approach. The "Standard" Approach/Landing sequence is Flap 1, Flap 5, Gear Down Flap 20, Flap 30.

Takeoff Flaps	At "Display"	Flap Transition Speed	Select Flaps
20 or 15	"20" or "15" "5" "1"	Vref 30 + 20 Vref 30 + 40 Vref 30 + 60	5 1 UP
5	"5" "1"	Vref 30 + 40 Vref 30 + 60	1 UP

Flap 15 on Approach

While specifically identified as a Takeoff Flap setting, the FCTM also refers to Flap 15 as suitable when manoeuvring prior to approach. Flap 15 is not recommended as a regular setting for a low drag approach – the FCTM specifically identifies the Gear Up / Flap 20 configuration for low drag during approach.

The use of Flap 15 does not require pre-facing it with "**Non Standard**". It's just a flap setting.

Flap 25 on Approach

Flap 25 on the other hand is specifically denoted a Landing Flap Setting by the FCTM. Unlike Flap 15 – the selection of Flap 25 does not result in a "25" minimum speed indication on the airspeed tape. Typically, PF calls for Flap 25 because of a fast/late approach where the aircraft is close to the Flap 30 limit speed. The lack of a minimum speed indication on the airspeed tape should be taken as an indication that Flap 25 should not be used during approach unless it's the landing flap selection.

15.12. MDA or MDA+50?

Usually a precision approach promulgates a Decision Height (DH) where the intention is that the decision to land or execute a missed approach is made as the aircraft reaches the minima. Consequently, the minima is selected to ensure terrain clearance as the aircraft momentarily descends through the minima while commencing a missed approach.

Many non-precision approaches promulgate a Minimum Descent Altitude (MDA) which is exactly that – if the aircraft descends below this altitude in IMC during the approach, terrain clearance is compromised. Accordingly, a 50 ft addition to the MDA is made to ensure a missed approach commenced from Minima(um) will not compromise terrain clearance. Or your check.

During circling approaches, the MDA is set in the altitude selector and the aircraft allowed to capture MDA and fly level in preparation for a turn to position for landing. As such, irrespective of the decision to land or go-around by the PF – the aircraft cannot descent below MDA, therefore there is no need to add 50 ft to the circling minima **as long as the flight path will capture circling MDA and not descend below it in the event of a missed approach at minima.**

There are hybrid approaches such as sidestep landings to adjacent runways where the decision to set MDA+50 or not may not seem clear. **Ask yourself this – "Am I going to fly level at the minima, waiting to intercept 3° to the landing runway, or do I plan on flying through the minima, because I'll already be on slope?**"

- If a level flight segment at the minima is expected, use MDA, set it in the MCP and capture it at the minima with the AFDS – setting Missed Approach Altitude at ALT/VNAV ALT Capture. When ready to commence descent to the runway, disconnect the AP, cycle the flight directors and truck on down.
- If (very) little or no level segment is required – set MDA+50 and re-set the MCP to the MAA at the appropriate time – don't allow the AP engaged AFDS to capture **ALT** and fly level.

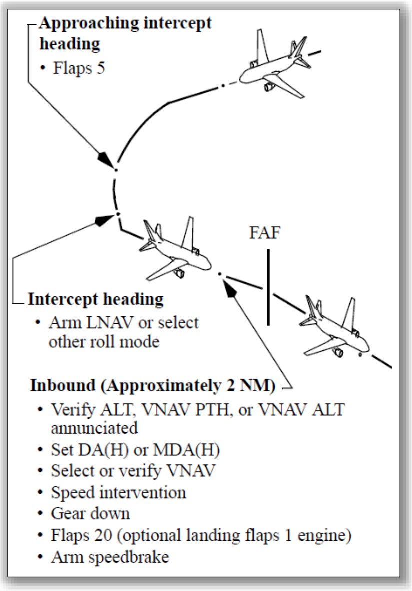
15.13. Modifying an Existing Hold

It's worth noting that you cannot modify an existing holding pattern once the initial fix has been over flown and the hold commenced. For example, if you are established outbound and wish to increase the holding time, you have to use Track Select to continue outbound (*did you start a clock?*) If you alter the holding parameters in the FMC, it then will overlay the new hold on the ND until you execute the modification, at which point the previous hold will remain. The new holding parameters will take effect once you transit the holding waypoint for the next hold.

This does not apply for holding entry – if you're still in the sector entry, you can modify parameters of the hold and the new hold will become active as you complete the entry. In effect each transit of the holding point brings with it a re-calculation of the hold the FMC is about to command, and that hold must be flown to completion before any subsequent modifications take effect.

15.14. VNAV Approach – Speed Jumps Up

When VNAV is engaged on approach (*or anytime*), the MCP Speed Window closes and the FMC takes over. Depending on when it's selected – this behaviour can result in a target speed increase (*along with the associated thrust and pitch changes*) as the FMC targets the descent speed, nominally 240 knots or as limited by the current flap limit speed. Even if the PF is quick to re-open the window and set the desired speed – it's annoying.



One reason VNAV would not command an increased speed is because an FMC LEGS page constraint has become the commanding factor. However, the point at which VNAV is typically engaged is prior to that point at which VNAV calculates a speed reduction is required to meet the typical 170 knot FAF speed constraint – hence the speed increase.

One solution is to fly the entire descent and approach in VNAV. This is the way the aircraft is designed to be flown. Note that while the descent may well be flown in **VNAV PTH** with the speed window closed – it must be opened for final approach, with the AFDS remaining in **VNAV PTH**.

Unfortunately, the designers didn't quite account for the amount of off path LNAV/VNAV vectoring ATC usually provide, and so FLCH is still the mode of choice for many vectored descents in to the initial approach.

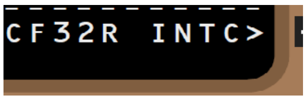
The second method is to place a LEGS page speed constraint at an appropriate waypoint so that the FMC will target the correct speed as you prepare for final descent – typically Flap 5 minimum speed (VREF30 +40 kts).

Note …

- **All VNAV approaches are flown with Speed Intervene active** from no later than the FAF – the speed is managed directly by the PF with **VNAV PTH** annunciated. Even if VNAV closed the MCP Speed Window and targets the correct speed – you must still Speed Intervene.
- Speeds can be changed on the LEGS page but altitudes at and after the FAF can only be adjusted for cold weather corrections.

The practice of pre-setting the appropriate approach speed in the VNAV Descent Page prior to engaging VNAV for the NPA is strongly discouraged. This would need to be done during the run in at platform altitude to the IAF/FAF and apart from being a source of distraction during the busy pre-approach environment, if done incorrectly could well result in a low speed excursion for the existing flap configuration. Setting the speed on an appropriate LEGS page waypoint is the best practice solution and can be done at altitude during approach preparation.

15.15. Extending the Centerline

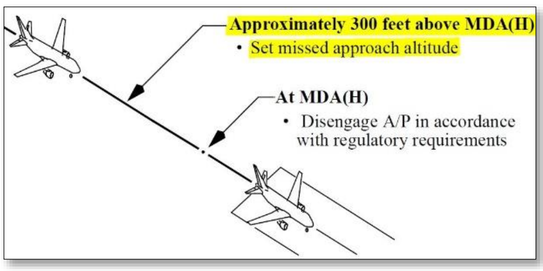


Typically, in our environment your aircraft will be vectored towards final approach (*or somewhere else*) destroying the usefulness of the carefully constructed lateral and vertical path of the STAR and initial approach. At some point during the vectoring (*earlier rather than later is usually best*) PF may well want the approach/runway centreline extended. This ensures a reasonably accurate VNAV profile, good distance to run on the progress page and helps mitigate the risk of being vectoring inside a waypoint on final.

You could choose a waypoint from final on the LEGS page, selecting it to the top and enter the approach track as the Intercept Course To – but it's worth noting that the DEP ARR arrivals page has all of this in one button press, including taking you automatically to the LEGS page to check the result.

As such a call from the PF "**Extend the Centreline**" would be followed by the PM selecting the **DEP ARR** -> LSK 6R **INTC>** button, then checking the result on the LEGS page, and a prompt back to PF such as "**Five Mile Fix, 160 Inbound, Confirm?**"

15.16. Basic Modes Approach; 1000 ft – Set MAA



The Boeing FCTM recommends setting the MAA approximately 300 ft above the MAA for certain NPAs. This recommendation conflicts with the standard call "**1000 ft – Missed Approach Altitude Set**".

Training/Standards recommend setting the MAA with the 1000 ft AAL standard call (*if not already set*) rather than waiting a few hundred feet later to set it in accordance with the FCTM

15.17. FLCH during NPA's

Often when a non-precision approach is going pear shaped and the aircraft deviates high on initial approach and not in **VNAV PATH** (*such as VNAV ALT/SPD, or forgetting to set the MDA/Intermediate Altitude, or forgetting to engage VNAV approaching the IAF, etc*) crew tend to revert to FLCH as a means of expediting their descent towards the required path. This is almost always a potentially dangerous action on the part of the PF. FLCH is not an approach mode and if the ALT selector is set below the minimum safe altitude for the approach segment, FLCH will take the aircraft below safety height. If FLCH is engaged with a lower altitude selected and the MCP altitude is subsequently set above the aircraft, FLCH will revert into a climb mode. In this way subsequent action to set the Missed Approach Altitude during this descent can seal the fate of the approach (Asiana 214).

4 November 2007
HS-TJW
Procedures-related event
Melbourne Airport, Vic.
Boeing Company 777-2D7

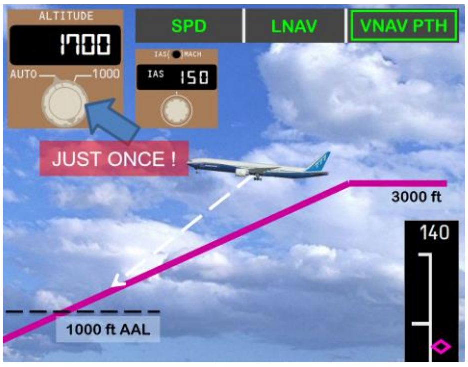
During such circumstances, the most reliable solution is usually to revert to set the altitude selector to the next constraint and initiate a VS descent with a rate of descent commensurate with the above path indication to expeditiously return to profile. As the intermediate constraint is approached and the aircraft is still not on path, the next constraint can be set. The approach should be terminated at 1000 ft AAL if not stable, earlier if it becomes obvious the approach will not be stable by 1000 ft, or anytime the crew are uncertain of their position with respect to the approach profile (*or are below it*).

Limitations -
Operating Limitations
777 Flight Crew Operations Manual

Autopilot/Flight Director System
Non-AFM Operational Information
Do not use FLCH on final approach below 1,000 feet AFE.

An alternative technique is to engage VNAV SPD descent (*lowering the altitude selector to the FAF or MDA and pressing the altitude selector is normally sufficient to achieve this*) and use speed brake to achieve a higher rate of descent to regain VNAV PTH, which will capture when the aircraft is within 150 ft of the programmed approach path. Crew must ensure that the LEGS page altitude constraints have not been accidentally cleared (*such as through multiple altitude selector presses*) otherwise a below safety height situation can occur. All of this require pretty high Situational Awareness, which may have been compromised when you got yourself into this situation ...

15.18. VNAV ALT on Approach



A common occurrence during a VNAV Approach is the **VNAV ALT** capture event. It's important to understand what VNAV ALT actually is, as an AFDS flight mode. If **VNAV ALT** is engages (*Climb or Descent, Departure or Approach*):

- You **ARE** in **VNAV** (*Thrust, Speed, Pitch primarily from the FMC*); and
- VNAV wants to Climb or Descend **NOW**; and
- The MCP Altitude Selector is in the way.

As such the first thing to do is correct the MCP Altitude Selector. On approach this typically means setting an intermediate approach altitude, or the Minima. While this frees up VNAV, this action will NOT commence a descent out of **VNAV ALT**.

The next step is to press the Altitude Selector **just once** – see **Keep pressing that Altitude Selector ... NOT**.

This will force VNAV out of ALT and into either PATH or SPD. In either case you are likely to be high on the approach. How high above the VNAV Path you are will direct VNAV into one of these two descent modes.

VNAV PTH : If you're now in PATH, this means that your recovery actions were completed within 150 ft of the calculated path. VNAV PTH will now reduce thrust (down to idle), and increase speed if required in order to regain the calculated vertical path to the next legs page altitude restriction.

VNAV SPD : VNAV was out of tolerance for a PATH engagement. Instead SPD mode will set idle thrust, pitch to maintain a descent at MCP speed and leave the aircraft to descend down onto the approach path. Note that you are **not** in the correct mode for the approach – although you are protected from descent below the FMC approach path. Should the descent be sufficient, **VNAV PTH** will engage as the calculated vertical path is approached. Should the VNAV SPD descent be inadequate, PF now has two options – increase drag (*Gear or Speed Brake*) or abandon the approach.

The determining factor in recovering from a **VNAV ALT** capture (*whether at the IAF or further down the approach*) is the stabilisation requirement at 1000 ft. If the PF determines that the aircraft will not be stable by 1000 ft, the approach should be abandoned. If the aircraft is not stable at 1000 ft AAL, a missed approach should be flown.

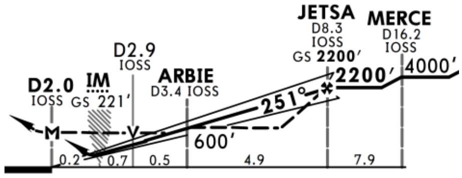
15.19. "Are you ready for the approach?"

Perhaps even more than the "**Can I close the door Captain**" question, this question gets more crew into trouble in the simulator than any other, usually at a time when the crew think they really have a handle on the flight. When asked this question, anticipate being cleared direct to the IAF, with an immediate descent to the initial approach altitude, add into the mix Charts, FMC Setup, Briefings, Descent and Approach checklists, Aircraft position, altitude and configuration – then answer the question. One more trip round the holding pattern might be just the ticket to get it all done/make sure it's all done?

One common manifestation of this error is holding in the holding pattern a thousand feet or more above initial approach altitude and advising ready for approach without sufficient track miles available to descend and configure in time for the IAF. Another is calling for the Landing Checklist and having the Descent Checklist display on the MFD.

15.20. Flying an ILS in VNAV/Basic Modes

The procedures described in the FCOM and FCTM for Precision Approach are principally based on the assumption you use the AFDS APProach Mode *(go figure)*. When flying an ILS approach using either Basic Modes (VS/FPA) or VNAV – then the procedures in the Non-Precision Approach FCOM/FCTM should be followed.



These procedures are intended primarily to protect the aircraft from descent below minimum/lowest safe altitudes when the autopilot pitch mode is not following a promulgated glidepath (*not in* VNAV PTH *with a coded LEGS page angle; or not in APP Mode* GS). In particular, the MCP Altitude Setting procedures in Basic Modes where the MCP Altitude Selector is used progressively down the approach to assist in preventing descent below the intermediate minimum safe altitudes are recommended.

Finally, the recommendation to cycle the flight directors at minima when the guidance provided after the minima is not to the runway threshold / threshold crossing altitude is just as relevant to a basic modes precision approach as is to all non-precision approaches.

15.21. Circling Minima

Crews should note that most Flight Operations Departments often impose a restriction on circling in large, wide body airlines – either increased minima *(such as the A1 minimum circling altitude of 1000 ft AAL and 5000m / 3 sm (US), over and above the Jeppesen published circling minima*); some operators do not permit instrument circling procedures in large, wide body aircraft.

15.22. LNAV into Localiser Capture

When vectored into a localizer associated with parallel runway operations, the AFDS LOC Capture logic can schedule up to two overshoots of the localizer dependant on the intercept angle, wind, groundspeed and other factors. This is not aberrant, but a programmed behaviour of the capture logic. However, an overshoot of the localizer during closely spaced parallel runway operations may be less than ideal. In this situation, where the localizer centreline is available in the FMC, LNAV can be used to initially capture the localizer without overshoot, and LOC/APP engaged once the initial LNAV capture is complete. Crew need to ensure LOC is engaged (*not just armed*) once established, and an awareness of the glideslope is crucial to ensure an above path situation does not develop.

Additionally, caution needs to be used when using LNAV to capture the localizer track with LOC armed – such as when transitioning from a STAR into the initial approach. Even in today's GPS guided, RPN validated navigation environment, the potential for LNAV to take the aircraft on a gentle intercept of the inbound track, then parallel the approach without actually achieving localiser capture still exists. Depending on your company specific implementation - GS might engage and commence a descent without LOC capture. Naturally an FMA aware flight crew would note that LOC was armed but not engaged, but still …

15.23. Localiser Approaches – FMC Selection

Typically, a localiser approach is selected in the FMC as the ILS approach, then validated as an overlay for the Localiser Approach.

However sometimes there is a Localiser specific approach in the FMC (*usually labelled* **LOC**). Typically, this occurs when the localiser approach varies from the ILS profile. If cleared for a Localizer Approach and there's a LOC specific approach in the database, it must be selected for the approach.

15.24. Autopilot and NPA Minimum

Without LAND 2 or LAND 3 (ILS Approach Mode) annunciated, the AP must be disconnected by 200 ft AGL.

Training/Standards further mandates AP disconnection on Non-Precision and Visual Approaches in accordance with the following.

Autopilot/Flight Director System

The autopilot must not be engaged below a minimum engage altitude of 200 feet AGL after takeoff.

Without LAND 2 or LAND 3 annunciated, the autopilot must be disengaged below 200 feet AGL.

- LNAV/VNAV Approaches where the FMC LEGS lateral and vertical path achieve the runway threshold at the threshold crossing height (*approximately threshold elevation + 50 ft*) – **AP Disconnect by 200 ft RA.**
- All other Non-Precision Approaches – **Leaving the Minima.**
- Visual Approach or Visual Segment from an Instrument approach where the FMC LEGS lateral and vertical path achieve the runway threshold at the threshold crossing height – **AP Disconnect by 200 ft RA.**
- All other visual approach/segments – AP Disconnect leaving previously cleared altitude.

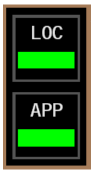
The basic principle is that if the Flight Directors are going to take the aircraft to the runway threshold at the appropriate altitude, the AP may be left engaged in LNAV and VNAV until the FCOM limitation of 200 ft.

Basic modes AP/FD manipulation to take the aircraft below MDA (or on a visual approach/segment) including circling MDA, is not recommended.

15.25. ILS Approach to Manoeuvre/Circle

When conducting this approach, remember that the aircraft will not intercept the MCP Selected Altitude with GS engaged, and the only way to get the aircraft out of Approach Mode after 1500 ft AGL LAND 3 (*such as to level off or turn to position onto downwind*) is to turn both flight directors off AND disconnect the autopilot. As such it is best not to use GS for the approach vertical mode. The recommended mode is therefore VNAV or failing that VS/FPA. While LOC would be the normal mode, it’s also acceptable to use LNAV to fly a Localizer as long as you ensure localizer tracking tolerance is maintained.

15.26. Arming Approach Mode



Selection of the APP mode push button on the MCP arms/disarms or engages/disengages AFDS LOC and GS modes, as well as isolating the electrical bus arrangement to ensure three autopilots have individual electrical power sources.

Depending on your Airline configuration, 777 AFDS can capture and descend on the GS prior to LOC capture. As a result of this feature, crews are often taught in the simulator not to arm APP mode until LOC capture has been achieved. One detrimental effect of this habit as common practice is that it is more likely to lead to regular occurrences of forgetting to arm APP mode.

Typically, ATC (*LAX is the exception*) do not vector aircraft onto a localizer above the glideslope (*that’s left for Instructors to do in the simulator*), so the trap inherent in the AFDS GS first feature does not normally present operational implications.

That said, in the situation where the aircraft **is** vectored onto the localizer close to (*or above*) the glideslope, the PF must decide on and implement an appropriate response to the early GS capture. This could be:

- **Allow the AFDS to commence the GS descent, monitoring for LOC capture.** In this case the aircraft must remain above MSA/LSALT until established within ½ scale deflection of the localizer. Part of implementing this course of action should be a verbal interchange between the PF/PM to ensure both are situationally aware of the descent in GS without LOC capture, and ideally establish a limit by which LOC capture is achieved, or the approach terminated.
- Advise ATC the approach cannot be commenced and ask for further vectoring.

Additional common practices related to the arming of LOC/APP mode are:

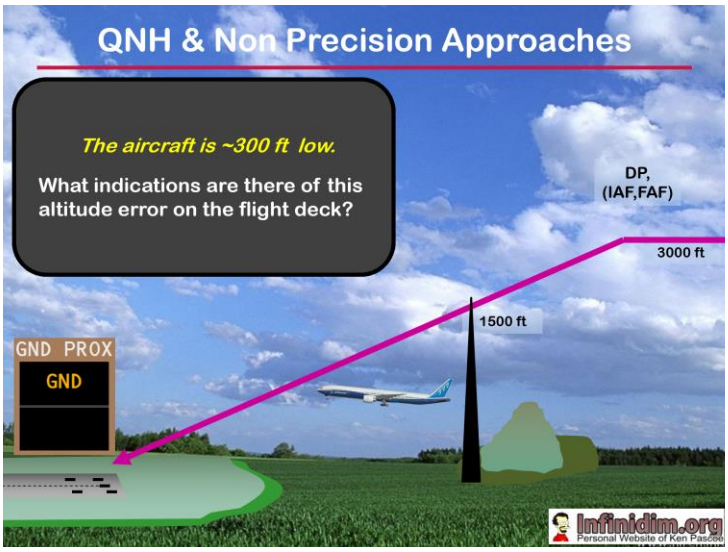
- Delay selection of LOC mode until cleared to intercept the localizer.
- Delay selection APP mode until cleared to commence the approach.
- Check for ILS ident and indications on the PFD when selecting LOC/APP mode to ensure the validity of the ILS signal.

All of these are common practices and good airmanship, as well as recommended practice in the FCTM.

15.27. Circling approach positioning by triangles

The use of the aircraft symbol triangle on a 10-mile scale ND for positioning during a circling approach can be a useful monitoring technique – **but cannot be used as a replacement for timing.** Wind adjusted timing must be the primary positioning technique when conducting circling approaches.

15.28. Non-Precision Approach With Incorrect QNH



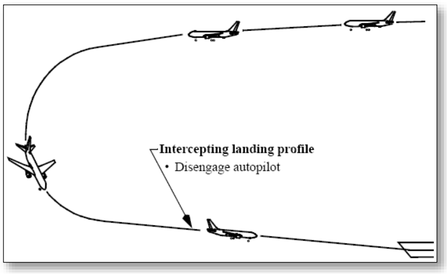
Without a ground based electronic glideslope – all Non-Precision Approaches are subject to the potential of reduced terrain clearance from errors in QNH.

With a 10mb error in QNH, an aircraft can be 300 ft low on approach. The only indication to the flight crew of this in IMC will be a miss-alignment between indicated altitude and radio altitude (*which requires consistent terrain leading into the runway and/or local knowledge*) or perhaps a particularly conscientious monitoring effort on the part of ATC. The first genuine indication is likely to be a ground proximity alert, but only if the forecast terrain contact point is outside the confines of the EGWPS alerting regime.

The solution is conscientious monitoring and cross checking by the pilots of QNH settings as provided by ATC and validated against the historical ATIS or METAR record. It's worth seeing this in the sim – ask your instructor to surprise you at some point.

15.29. Circling Approach : Descent from MDA using AP

A technique commonly taught during circling approach manoeuvring is to use the AP in VS or FPA mode to commence descent from circling MDA when turning Base on the visual circling segment. This technique reduces workload during the initial part of the visual circling/descent manoeuvre and allows the use of automation further into the approach.



The FCTM text is clear that the AP is to be disengaged when "**leaving the MDA/H**" for final descent after the circling manoeuvre. Boeing are pretty comprehensive on this statement throughout the FCTM.

The second issue is that the PF is now in an open descent in a non-precision AFDS mode with no safety floor – no MCP Alt selector to catch the aircraft, no **VNAV PTH** to provide guidance to the runway threshold.

While initially suitable, VS quickly becomes patently unsuitable as the vertical path begins to require the detailed adjustment only manual flight can provide – the same issue applies to lateral nav, which is typically HDG/TRK SEL at this point.

It should be noted that Boeing have been consulted on this issue and their response was adamant – the use of AP below MDA on NPA approaches which constitutes an open descent is unacceptable. Reference is often made to the FCTM Circling Approach diagram that shows AP disconnect on final. Boeing's response is that this diagram is based on a circling height of 400/500 ft and as such the annotated AP disconnect point is not applicable to our operation. If we were circling at 500 ft in a Boeing 777-300ER – we'd be on final (*and still at the circling minima*) as well.

15.30. Visual Reference at the Minima (NPA)

The visibility required to commence a non-precision approach does not guarantee sufficient visual reference at the minima to continue to a landing. This is particularly the case for NPA's based on JAR/TERPS.

Given that the crew may disconnect the AP and manoeuvre visually from the MDA to the runway, crew should ensure that adequate visual reference exists to do so at the MDA.

Approach	MDA (AAL)	RVR/Viz Req'd		Basis	Appr Lights	Glide Slope	Dist to Appr Lts	Viz Gap
SYD RW16R RNAV	520 ft	2900 m	V	PANS4	300 m	3.0 °	2728 m	172 m
BNE RW19 RNAV	420 ft	2300 m	V	PANS4	600 m	3.0 °	1846 m	454 m
MEL RW16 RNAV	460 ft	2500 m	V	PANS4	600 m	3.0 °	2079 m	421 m
LAX RW25R RNAV	540 ft	1609 m	V	TERPS	720 m	3.0 °	2425 m	-816 m
AUH RW31L VOR	460 ft	1600 m	R	JAR	720 m	3.0 °	1959 m	-359 m
DXB RW30R RNAV	550 ft	1600 m	R	JAR	720 m	3.0 °	2483 m	-883 m

15.31. Unnecessary Actions during Circling Approaches

Flight crew should avoid unnecessary actions during circling approaches. Once the aircraft has broken off from the final instrument approach to position visually for landing, the crew should focus on manoeuvring the aircraft procedurally with respect to the landing runway, as well as maintaining visual contact with the landing threshold and/or approach area. The following actions have been observed during sim check/training. In most cases these actions are superfluous and in fact distract unnecessarily from the safe positioning of the aircraft for landing.

- Selecting the landing runway in the FMC
- Extending the centre line and other FMC lateral manipulations.
- Updating Fix page rings and bearings
- Altering MCP HDG/TRK and VS selections to provide Flight Director guidance after leaving circling MDA.

Some of these actions can provide extremely useful backup information to the PF/PM during circling approaches in minimal (5K) visibility. Without exception however alternatives can be found that can be pre-programmed and briefed in advance, and not impact on workload during the circling manoeuvre.

15.32. Glideslope Intercept From Above

Intercepting the glideslope from above is typically not good airmanship and in some cases is prohibited by some airline SOPs - the implied threat is the potential to intercept a false glideslope.

However, if the crew are confident in their situational awareness and in the circumstances that have led to being above the glideslope (or they're in LAX), the following procedure can minimise the risks of intercepting the glideslope from above.

AP Engaged (FCTM)

- Set the altitude selector to 1000 ft AAL (approximately).
- Ensure **LOC is engaged**, **GS is armed,** and the aircraft is **ABOVE** the glideslope.
- Engage VS and select a high rate of descent (*generally at least 1500 fpm is required*).
- If the VS requirement results in idle thrust and an increasing airspeed, the use of some Speedbrake can assist in regaining path. Note the FCTM recommendation against Speedbrake at flap settings in excess of Flap 5.
- Monitor the approach (*especially vertical path cross checks*) until GS capture is achieved.
- If it becomes clear that the aircraft will not be stable by 1000 ft AAL, the approach should be abandoned.

PF	PM
Arm APP Mode.	
Set MCP Altitude no lower than 1000 ft AAL.	
Engage VS Mode.	
Warning : Ensure Localizer tolerance is within limits before descending – ideally LOC should be captured.	
Set desired vertical speed.	Monitor progress of Glideslope closure. Call "**Glide Slope Alive**" when appropriate.
At glideslope capture, set MAA.	
Note : If GS is not captured (or will not be captured) by 1000 ft AAL – or if ALT engages – go-around.	

Sometimes the automation gets in the way of a relatively simple above glide path correction. It may be simpler to disconnect the AP and push the nose down to establish the required descent rate for a glideslope intercept. As long as the A/Thr is in **SPD** mode on the FMA, it can remain engaged during this manoeuvre. As soon as GS has engaged on the FMA, the AP can be re-engaged or a normal manually flown ILS approach can be continued.

Manual Flight (FCTM)

- Set the altitude selector to 1000 ft AAL (approximately).
- Ensure **LOC is engaged**, **GS is armed** and the aircraft is **ABOVE** the glideslope.
- Disconnect the AP and increase the rate of descent commensurate with the requirement to capture the glideslope.
- Speedbrake can be used to assist in regaining path. Again note the FCTM recommendation against Speedbrake at flap settings in excess of Flap 5.
- Monitor the approach (*especially vertical path cross checks*) until GS capture is achieved.
- If it becomes clear that the aircraft will not be stable by 1000 ft AAL, the approach should be abandoned.

Potentially the PM could be utilised to engage and set VS to provide flight director commands to a glideslope capture point. However, this increases the workload on the PM, reducing the PM's capacity to monitor, without a significant increase in flight safety.

Use of FLCH SPD (Alternative) – AP Only

> Limitations - Operating Limitations
> 777 Flight Crew Operations Manual
> **Autopilot/Flight Director System**
> **Non-AFM Operational Information**
> # Do not use FLCH on final approach below 1,000 feet AFE.

The VS method above is recommended by the FCTM on the basis of allowing speed to accelerate (*up to Flap Limit Speed*) in order to achieve a required high rate of descent. When on approach from above the glide slope **and under speed control** (*sound familiar?*) – **FLCH** can be a better option. VS requires the PF to monitor and manipulate the VS rate of descent to achieve path capture while simultaneously using Speedbrake to control airspeed. **FLCH** removes the duplicate control mechanisms and requires the PF to only manipulate Speedbrake.

Using the above AP engaged methodology, engage **FLCH** instead of **VS**. Once established in an idle descent at commanded speed, use speed brake as required to increase the rate of descent down onto the glide slope.

- Ensure **APP** (GS) is armed; Ensure LOC is engaged; Ensure the aircraft is <u>above</u> the glide slope;
- Ensure GS capture prior to descent below the glide slope and well before 1000 ft AAL.

<u>**Note**</u> : If the MCP Altitude Selector is commanding a Level Change of greater than 3000 ft, **FLCH** will quickly close the thrust levers to idle. An altitude change request less than this will result in a slow retardation of thrust towards either idle or a setting somewhere above idle. In all cases – after engaging **FLCH** the PF can close the thrust levers manually and the auto throttle will engage in HOLD at idle thrust. Remember that in HOLD - while SPD <u>will</u> engage when GS captures, **for the moment - you have no speed protection**.

CAUTION : **As long as the Altitude Selector is set <u>at/above 1000 ft AAL</u> and <u>below the aircraft</u> and the AFDS glideslope capture mode is armed, the use FLCH SPD prior to Final Approach in this manner can be considered acceptable**.

15.33. Flt Director OFF at Minima?

The FCTM recommends that both F/D's be turned off and the PM F/D selected back on once the aircraft has left the MDA(H) after a basic modes (VS/FPA) non precision approach. The intent is to remove poor flight director command indications from the PF's PFD.

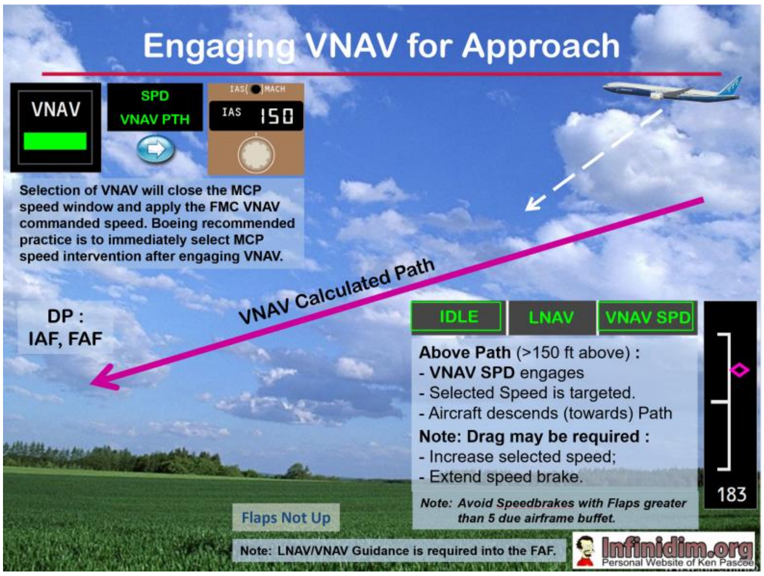
> Leaving the MDA(H), disengage the autopilot. Turn both F/Ds OFF, then place the PM's F/D ON. This eliminates unwanted commands for the PF and allows continued F/D guidance for the PM in the event of a go-around when pitch or roll mode is changed. Complete the landing.

When using VNAV for the approach, the flight directors should be left on as long as the flight director indications will be correct after the minima all the way to the threshold. This means that the runway threshold (*or equivalent*) must be in the LEGS page as a waypoint, with the correct threshold crossing altitude. There are still some approaches that meet VNAV validation requirements, but in which the runway does not form part of the approach, or the altitude crossing restriction is inappropriate for the runway elevation – such as those with a missed approach that turn before the runway threshold. In these instances, both F/D's should be turned off and the PM cycled back on. This is also required for Basic Modes ILS (*in the sim – where else?*)

There's a crucial point that's missed in the understanding of cycling flight directors at the minima. The important part of this process is to achieve a point during the procedure where **both flight directors are <u>OFF</u> at the same time**. If this is done, and the Autothrottle was <u>engaged</u> in any mode including – especially – HOLD; the Autothrottle will revert to SPD mode and provide speed protection for any subsequent manoeuvring. However if the A/Thr was not engaged during F/D cycling, it may not engage in SPD as required – the MCP A/THR switch will achieve this for you.

The requirement to cycle the Flight Directors at minima on any non-precision approach should be identified during the setup/cross check and highlighted during the arrival briefing.

15.34. VNAV Path Intercept from Above



While the FCTM publishes a **VS** procedure for intercepting an ILS glideslope from above, the use of VS is not appropriate for intercepting the FMC VNAV Path from above.

Instead, **VNAV SPD** is used.

Assuming VNAV engagement in excess of 150 ft above the path, VNAV SPD should be an idle thrust descent with the elevators commanding FMC/MCP Selected Speed.

Once the thrust levers reach **IDLE** (*or if the PF overrides*), thrust can be set manually to moderate the rate of descent to comply with maximum descent rates in the terminal area.

Typically, however the requirement is to expedite the descent rate, which is usually done with the Speedbrake.

While VS may give a more direct control of the rate of capture onto the FMC path, since VNAV cannot be armed, the PF would be required to select VNAV once the aircraft approached the path, potentially exposing the aircraft to a below path situation.

15.35. "Localizer" vs "Localizer Capture" (... and Glideslope ...)

The correct FMA call is "**Localiser Capture**" – not "**Localiser**". Similarly, it's "**Glideslope Capture**" when annunciated on the FMA, and "**Glideslope**" when it's all going wrong and the PF is high or low on the ILS Approach. Even better is "**Glideslope Capture ... Missed Approach Altitude Set.**"

15.36. Manoeuvring below Minima – Visually

One of the more challenging manoeuvres in large aircraft is manoeuvring laterally and vertically after the minima – such as in a circling or side step landing. This can be particularly challenging in the simulator where visual references can be less than ideal despite the high level of visual sophistication.

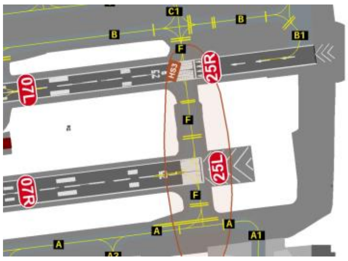
The nature of the 777 operation tends to limit the opportunities for hand flying, let alone manoeuvres such as circling and/or visual circuit approaches. As such there is a tendency to turn a visual manoeuvre into a numbers game, relying on information such as distance to run, height above the ground, VNAV path information, distance/tracking/path trend information from the ND, and more. A good pilot understands the strengths and weaknesses of the various sources of glass information during all stages of flight – but it is a common error of glass pilots during manoeuvres which are essentially visual to rely too heavily on the numbers and not enough (*or at all*) on the visual references required by such manoeuvring.

Accurate data provided within the glass flight deck can provide a valuable cross check to a visual manoeuvre – but should not become the primary reference for flying the aircraft below the minima.

The classic example of flight deck information backing up a visual flight manoeuvre is visual at the minima on a Cat I ILS Approach. While visual reference must be established with the approach lights in order to continue below minima (*implying correctly that exterior visual reference is all that's required*) the ILS glideslope and localizer will typically provide accurate course information down to the runway and should be used as a cross check of the visual picture. It can be a big ask for the PF to adopt quickly from the IMC to VMC environment (*as well as flying manually*) at the minima. The PF's scan at the minima should retain a cross check of the GS and LLZ position and trend, with this instrument component of the scan becoming less and the aircraft nears the runway and the visual references improve.

Another common example is manoeuvring during a circling or side step manoeuvre to a runway that is not active in the FMC. Placing the landing runway in the Fix page, along with a course line to emulate final approach and a three-mile range ring (*indicates approximate descent point for 3 degrees from the 1000 ft circling minima*) can significantly improve situational awareness during the manoeuvre - but must not replace the use of visual references. If the landing runway is not active in the FMC, it is not available to the Fix page – however the Fix page will allow for the selection of runway waypoints in Route 2.

15.37. KLAX Runway Change / Side Step



SIDESTEP LANDING RWY 25R	
MDA(H) 540′ (436′)	
	RAIL/ALS out
RVR 55 or 1¼	
RVR 55 or 1¼	1¾
1½	2

KLAX publish side step minima on instrument approach charts for landing on the adjacent runway. In this context, adjacent means a like-numbered runway (*eg: RW25L -> RW25R **not** RW24.. -> RW25..*) It's worth noting that KLAX ATC consider a "side step" to be an instrument approach, or more correctly a visual manoeuvre after an instrument approach, but essentially – NOT a visual approach.

Side Step minima and manoeuvres are in place to maximise traffic throughput in the event of an ILS failure on the landing (outer) runways at KLAX. For example, in the event of a localiser failure on RW25L, pilots might expect to be cleared for the ILS Approach for RW25R, with a sidestep to RW25L. Departures will continue off RW25R during this procedure.

Note that at KLAX all ILS's radiate irrespective of the nominal "Landing" runway, unless ATIS/NOTAM'd otherwise.

The *procedurally* correct missed approach off a side step is that associated with the approach flown for the non-landing runway. However, KLAX ATC will always issue a specific heading/altitude for a missed approach of any approach into KLAX – see **Missed Approach Procedure - KLAX**.

Consideration should be given in the event of a Runway / Approach / Airport change to re-running the Descent and Approach checklists if the change occurs after they were completed. Not always necessary, not always practical – but worth a thought.

15.38. LVOPS – the Last 50 ft

Being nearest the ground, the last fifty feet are crucial during LVOPS. Shortly after "**Fifty Feet**" the thrust levers begin to close (Right Hand) as the A/THR commands **IDLE** on the FMA. Shortly after "**Thirty Feet**" the AP commences the flare (Left Hand) as the AP commands **FLARE** (engaged) on the FMA. Shortly after "**Ten Feet**" **ROLLOUT** engages to ensure localiser centreline tracking.

While the Captain can detect the first two changes through tactile feedback against the auto callouts ("**Fifty**" = Right Hand; "**Thirty**" = Left Hand), the First Officer is crucial to back up lack of mode engagements through the appropriate "**NO Idle / NO Flare / NO Rollout**" calls.

15.39. Reverse Thrust During Landing – Idle

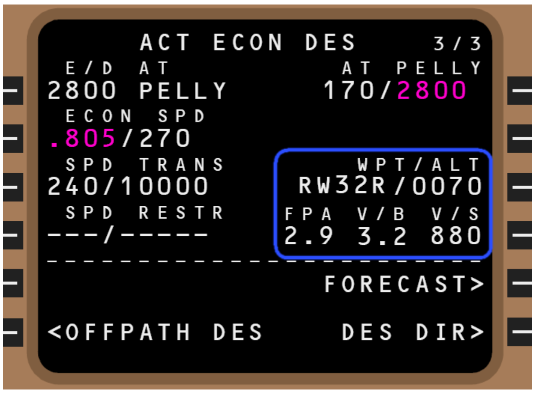
The use of Idle Reverse on landing is a tool to be employed when landing conditions and available runway permit. Idle reverse reduces noise and is sometimes a requirement at noise sensitive airports. Refer to **Carbon Brakes – Operating Differences** for details on the use of Idle Reverse and low Autobrake settings.

Landing Roll Procedure

Pilot Flying	Pilot Monitoring
Without delay, raise the reverse thrust levers to the interlocks and hold light pressure until the interlocks release.	Verify that the forward thrust levers are closed. When both REV indications are green, call "REVERSERS NORMAL." If there is no REV indication(s) or the indication(s) stays amber, call "NO REVERSER LEFT ENGINE" or "NO REVERSER RIGHT ENGINE", or "NO REVERSERS"
Apply reverse thrust as needed.	

Prudence dictates (*and the FCOM requires*) the initiation of reverse thrust to at least the idle detent for all landings – including those in which the application of reverse will finish at the idle setting. Bringing the levers into the idle position also allows for the application of full reverse thrust relatively quickly should conditions change during the landing roll that necessitate a maximum braking effort.

15.40. CDU VNAV DESC Waypoint/Alt – FPA/Bearing/VS information



The CDU Descent Page can provide useful vertical guidance when manoeuvring visually below minima, particularly to a runway that is not active in the FMC. While this is a visual manoeuvre and such information should not be used to replace pilot judgement (see **Manoeuvring below Minima – Visually**) – the vertical bearing and vertical speed information presented here can be used as valuable cross check and indicates the point at which a 3° descent should be initiated, particularly in the simulator when the PAPI's may not be clear.

Overview

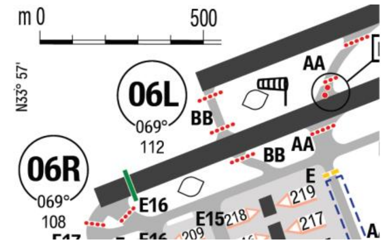
This section of the CDU Descent page operates independently of the rest of the FMC. It does not relate to VNAV Path calculations, it does not look at the route in the LEGS page (*in fact the waypoint does not need to be in the LEGS page*). Purely and simply, based on aircraft position/altitude, the Waypoint/Altitude in the WPT/ALT line (3R) – it provides:

- **FPA** : The aircraft's current Flight Path Angle (*at or below level flight – no climb indications*)
- **V/B** : The Vertical Bearing to the Waypoint/Altitude constraint in a direct line
- **V/S** : The VS required to maintain the Vertical Bearing requirement at current ground speed.

This information can be very useful as a means of increasing vertical path situational awareness when the rest of the FMC is not providing useful information to the PF – specifically when manoeuvring away from the approach runway to the landing runway, such as during a sidestep manoeuvre.

The default waypoint chosen by the FMC is the next LEGS page waypoint with an altitude constraint – the waypoint cycles through as each waypoint/constraint is met if not set manually.

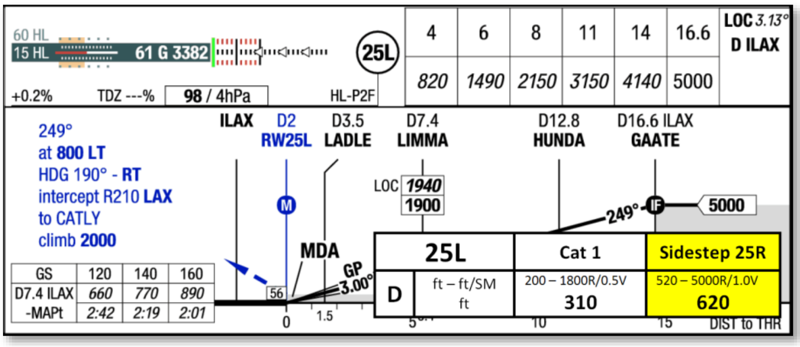
Approach to a Side Step Landing



The Bearing/VS information can be particularly useful when transitioning from an approach on one runway to a landing on another in less than optimal visual conditions. The aircraft transitions from an environment where a wealth of distance/altitude/profile information is provided to the PF, to an environment where even basic direct distance to the runway can be unavailable. While manoeuvring to final the Bearing/VS to the Landing Runway improves situational awareness with respect to the desired 3°approach slope. However, while every waypoint in the ARINC database is available to enter into the VNAV DESC page WPT/ALT prompt – a runway that is not active in the LEGS page is not. Of course.

When the FMC is setup for an approach to one runway (eg: KLAX RW06R) but the landing will be on another runway (RW06L) the FMC WPT/ALT prompt will not accept the RW06L waypoint. However if the crew select the landing runway in the DEP/ARR page (eg: RW06L ILS Approach) ***without executing the modification***, this inserts the waypoint into the LEGS page and therefore makes it available for use elsewhere (FIX, VNAV Off Path Desc, VNAV WPT/ALT) The runway waypoint can then be line selected into the scratchpad, the threshold crossing height added (eg: RW06L/0162) and the result inserted into the WPT/ALT field. The pending modification can then be erased – the waypoint and information will remain on the VNAV Descent or Fix Pages as desired.

15.41. Late Runway Change



Airports with multiple parallel runways, particularly closely spaced parallel runways such as KLAX, present crew with the potential challenge of a late runway change.

It's worth noting that the difference between a runway change / runway side step / circling procedure is a blurred line. If changing the landing runway during an instrument approach is to be considered a circling approach – company A1 minima of 1000 ft AAL and 5000m visibility would be required.

A late runway changes presents a few unique challenges to today's modern aircraft and is not a manoeuvre to be undertaken or accepted under impulse or without forethought – particular when …

- Late runway change/sidestep has not been practiced in the simulator;
- Comes at the end of a ULH flight with a moderately fatigued (*or worse*) crew;
- Is not reviewed, practiced and encountered regularly;
- Has not been pre-briefed as part of the pre-descent Arrival Briefing.

Of these four points, a thoughtful and concise briefing is a big factor completely within the control of the operating crew. A late runway change presents the following issues that must be addressed during the Arrival Briefing:

- **Weather** – what minimum visual conditions will be acceptable to accept a runway change.
- **Altitude** – what is the latest point at which the crew will accept a runway change. (*A1 requires at least 2000 ft AAL*)
- **Stabilisation Criteria** – The A1 requires a stabilised approach by 1000 ft (*or 500 ft for a visual circuit*). Acceptance of a late runway change or sidestep procedure should result in the aircraft established within criteria by 500 ft AGL.
- **FMC Procedures** – Crew need to pre-determine what their actions will be with respect to Runway and Approach Selection in the FMC during the manoeuvre. Nothing done or not done in the FMC affects the aircraft's ability to land on a runway, but if the approach and runway is not selected, the published missed approach will not be available either – or worse, LNAV will engage and attempt to follow the wrong missed approach.

Note that at KLAX all ILS's radiate irrespective of the nominal "Landing" runway, unless ATIS/NOTAM'd otherwise.

Missed Approach

Which missed approach will you fly? Which one do you have in the FMC? What do ATC expect? These questions should be discussed in the Arrival briefing and if necessary, clarified with ATC. Typically, if you're cleared to land on RW25R, you expect to fly the RW 25R ILS missed approach procedure. But part of the issue depends on when you agree to the runway change. It's entirely acceptable to be cleared for "ILS Approach 25L, cleared to land sidestep RW25R" based on the adjacent runway landing minima on the RW25L chart. In this case, based on the rules of manoeuvring for the runway after the instrument segment of an instrument approach – ATC would probably expect some form of the RW25L missed approach flown. Or would they?

Consideration should be given in the event of a Runway / Approach / Airport change to re-running the Descent and Approach checklists if the change occurs after they were completed. Not always necessary, not always practical – but worth a thought.

15.42. Visual Approaches

Visual approaches present some unique challenges to long haul operations. Limited currency and the significant fatigue levels encountered during the descent and approach phase often turn a manoeuvre the domestic pilot uses frequently as a significant time and fuel saver into a potential safety risk.

Don't Abandon the Instrument Approach

Visual approaches are used at high density, multiple runway capital city airports to reduce the traffic separation requirement associated with an instrument approach. Crew are expected to accept a visual approach as long as visual traffic separation is adequate and visual reference can be maintained - although acceptance is not mandatory.

However, crew should not abandon the procedural nature of the instrument approach that was planned and briefed. While complying with the ATC visual approach requirement, crew should follow the instrument approach procedures, AFDS mode engagements, Standard Calls and Standard Procedures of the planned and briefed instrument approach to the landing runway. This includes maintaining the instrument approach minima settings and minima standard calls.

AP/FD Use & MCP Altitude setting – AAL + 1000ft

It is recommended that the FMC be prepared to provide a 3° slope to the runway threshold / threshold crossing altitude for visual approaches where a backup instrument procedure is not available. The Flight Director and AP can be used in LNAV/VNAV, even if only to a point where the aircraft is established on final approach slope to the threshold. The use of AP during this manoeuvre is encouraged if it results in a lower workload and higher situational awareness for the PF/PM. With FMC guidance to the threshold, the AP can only be left engaged in LNAV/VNAV for visual approach manoeuvring down to **200 ft AGL.**

For any visual procedure/segment - if LNAV/VNAV are not programmed to THR and TCH, the AP must be disconnected when leaving the last cleared altitude.

If the AP/FD is used to leave a previously cleared altitude for a visual segment/approach, in order to commence the visual descent a lower altitude may need to be set in the MCP. Training/Standards recommends setting **1000ft AAL** (*eg: YMML RW34 SHEED arrival - **1400 ft***) to initiate the final approach descent. Once descent has progressed to at least 300 feet below the Missed Approach Altitude, the MAA should be set in the MCP.

Which Missed Approach?

If an aircraft is cleared for a Visual Approach in Australia, then subsequently executes a go around, the AIP stipulates a missed approach that tracks straight ahead, climbing to 1500 ft AAL. – there are exceptions to these rules such as Sydney and Brisbane.

Internationally when a visual approach is offered and accepted from an instrument approach, any subsequent go-around should follow the missed approach procedure of the originally assigned instrument approach.

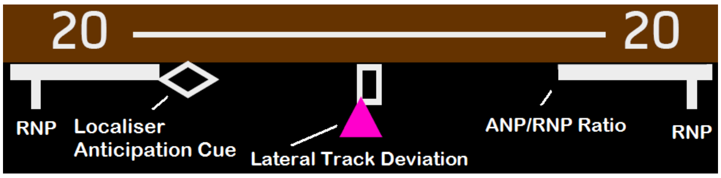
An additional complication is late runway changes or runway side steps – typically transitioning from an instrument approach off one runway to a visual approach on an adjacent one. What is to be the missed approach procedure? In practice ATC will normally provide immediate tracking guidance to an aircraft advising of a missed approach.

When in doubt – confirm with ATC the missed approach procedure required prior to having to execute it ...

In Summary

- Be wary of accepting Visual Approaches – ideally crew should brief for the possibility during the Arrival Briefing.
- If at all possible - continue the tracking, AFDS use, procedures and calls of the instrument approach when accepting a visual approach from a previously planned and briefed instrument approach.
- When the Visual Approach will be the primary procedure, prepare the FMC ahead of time to provide guidance and facilitate if possible, the availability of LNAV/VNAV AP/FD for the manoeuvre.
- AP use during a Visual Approach is encouraged – but not below 200 ft AGL (LNAV/VNAV); otherwise disconnect the AP (and cycle F/Ds) leaving the last cleared altitude.
- If a lower altitude is required in the MCP to initiate an AP/FD visual approach, use AAL+1000 ft.
- If the FD's will not provide guidance to the threshold, cycle both FD's OFF and the PM back ON when disconnecting the AP.
- Ensure you have a clear understanding of the required missed approach procedure when accepting a clearance for a visual approach segment.

15.43. Navigational Performance Scales (NPS)

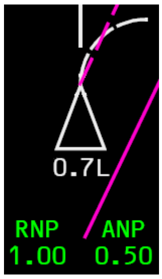


The navigational performance scales incorporate both an ANP/RNP scale and lateral track displacement display. Also included is a localiser displacement "Anticipation Cue" which displays when the ILS is tuned.

ANP/RNP Scale : This is the top part (*horizontal white band*) of the NPS. The edge markers (*small vertical white stripes at either end*) reflect the RNP requirement. The horizontal white band grows with ANP growth as a percentage of RNP. Thus, if the RNP is 4 and the ANP is 2, the horizontal white band will be 50% of its way from the edges towards the centre. When ANP exceeds RNP the band will be solid across the display, turn amber and flash briefly.

Lateral Track Deviation : The magenta triangle indicates track deviation as against FMC generated required track. It is a command instrument – pointer to the right indicates a requirement to turn right to regain track. The background scale of deviation is the current FMC RNP requirement. When lateral track deviation exceeds the ANP/RNP scale of the NPS (the RNP) the edge indications will turn amber and flash briefly.

Anticipation Cue : While typically thought of as the Localiser Pointer, this indicator actually "*Represents the relative position of the path for the selected and activated approach*". Got it? Think of it as the Localiser Pointer for now. The equivalent glideslope indication is available on vertical component of the NPS as well.

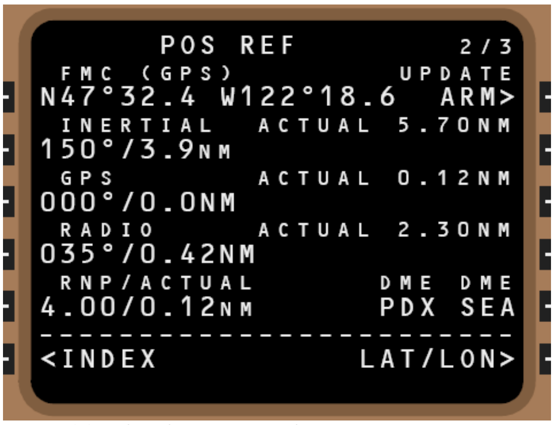


Track Deviation / ANP-RNP Combination : All this comes together in the NPS. The lateral NPS provides a linear representation of ANP/RNP percentage, indicating the degree of navigational accuracy inherent in the equipment being used to determine position. At the same time the lower NPS scale indicates the degree of track displacement being achieved by the crew. The combination of these two displays in the NPS indicates the navigational safety of the aircraft – the Cross-Track Error.

In the example pictured here, the aircraft is operating to RNP 1, experiencing ANP 0.5 (*such as during DME/DME updating*) – so the RNP/ANP scale reflects a 50% reduction in available manoeuvring area on the NPS. At the same time the crew are off track by 0.7 miles – the aircraft is beyond the navigational tolerances of the approach.

15.44. ANP, RNP, Position and Position Accuracy

ANP/RNP can be a poorly understood concept. This section attempts to clarify the meaning of ANP/RNP as well as explain in detail the navigational performance scales (NPS) option installed on 777 aircraft.

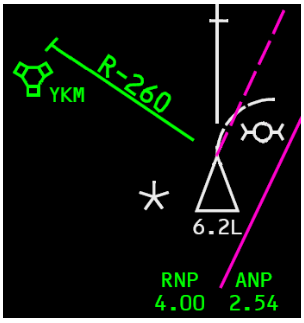


RNP : Required Navigation Performance attempts to move the focus away from specific navigational equipment (IRS, GPS, Radio/Nav, ILS, VOR, etc) and instead defines a standard of general use navigational accuracy. RNP10 (*for example*) is in common use in Oceanic Airspace – in this context, it means that an aircraft is required to be able to determine its position to within an accuracy of 10nm at least 95% of the time.

FMC RNP : It must be realised by crew that the FMC RNP values (*which are displayed on the ND/PFD*) are for the most part default values applicable to the phase of flight (*takeoff, en-route, oceanic/remote, terminal, approach*) and do not necessarily reflect the actual airspace requirement the crew find themselves in. Pacific Oceanic is typically anywhere from RNP2 to RNP10 – the FMC however generally operates to RNP4 or RNP2 in cruise at high altitude. These defaults are selectable by the airline operator and can be overridden by the crew in the FMC. However as long as you are operating to an RNP that is less than the airspace you are in, there should be no reason to manually set a value.

ANP : Actual Navigation Performance reflects the manufacturer guaranteed accuracy of the position determination mechanism of a navigation system. In the 777 there are three sources of geographical position determination – the GPS, the ADIRU and Radio/Nav position (*Radio Navigation as managed by the FMC*). At any given time (*when able to determine a position*) each line on CDU POS REF P2 will display the calculated ANP figure.

FMC Position : The FMC determines a separate position based on one (*or all*) of the three onboard positioning systems (GPS/IRS/NavRad). The FMC position is of prime relevance in actual aircraft operation - irrespective of the status of GPS/IRS/NavRad/ANP/RNP – the AFDS (*through LNAV*) follows the FMC position. The FMC position is the basis of the top of the triangular aircraft symbol on the ND Map, and the basis for the ND Map display itself. Typically, the FMC will choose the navigation source with the lowest ANP as its prime determinant in calculating aircraft position (*usually GPS*) but it must be clearly understood that the FMC keeps its own track of aircraft position.



RNP/ANP vs Position : It's important to understand that RNP/ANP bear little relevance to the aircraft's actual position. RNP may be 0.3 and ANP may be 0.06 but that doesn't stop the aircraft being 1 mile left of track if incorrect crew procedures are used on approach. RNP/ANP is a measure of position determining accuracy – not a measure of how far from desired track the aircraft is.

NAV UNABLE RNP : Anytime the ANP exceeds the RNP, EICAS (after a short delay) will prompt with the ❑ **NAV UNABLE RNP** advisory/caution message. The relevance of this message needs to be clearly understood by the crew. In cruise over the Pacific (RNP10), this is likely to mean the GPS has failed, but since the FMC defaults to RNP4, it may not reflect a true loss of required navigational accuracy. The **NAV UNABLE RNP** message on final approach is a different issue altogether.

15.45. Reverse Thrust Before Landing

There is a tendency during the flare for the PF to allow the thrust hand to move forwards to the reverse levers prior to the point at which the main wheels have touched down. This should be discouraged. Accidental lever actuation will not deploy the reversers until touchdown, but it does seem to cause reverser deployment to commence as soon as weight on wheels is signalled, along with Speedbrake deployment earlier than usual, with an associated "firm" landing.

15.46. Reverse Thrust After Landing

Thrust reverser lever movement should be commenced by the PF as soon as the main wheels are on the ground. There is no requirement to delay thrust reverse until the nose wheel has been lowered – indeed this only serves to increase landing distance.

16. Go-Around, Missed Approach

16.1. Missed Approach Procedure - KLAX

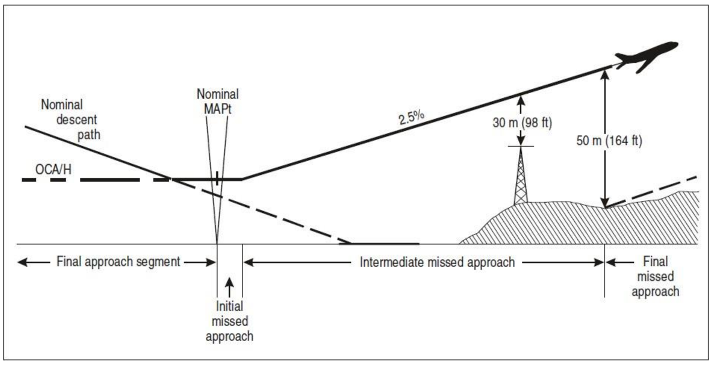
Operation into KLAX introduces a few traps into a missed approach. According to KLAX ATC (TRACON) any ATC initiated go-around will come with specific heading and altitude requirements which override any published instrument missed approach.

Unlike the Australian AIP, US TERPS do not publish a "standard" missed approach from a **visual** approach/procedure – and in any case any ATC initiated go around will usually come with the aforementioned specific heading and altitude requirements.

In the event of a **pilot initiated** go-around from **any** approach into KLAX (*instrument, runway side step, visual, etc*) – ATC expect the pilot to advise of a go around as soon as practicable, and specific heading/altitude instructions will be provided. This has implications for our auto **TOGA** to **LNAV** AFDS go-around logic. During the go-around the PF will have to fly through or replace (**HDG SEL**) the automatically engaging missed approach LNAV guidance to follow ATC missed approach instructions.

16.2. Missed Approach Acceleration

ICAO PANS OPS (missed) approach construction specifies that member countries are to assess the missed approach flight paths for intermediate acceleration to a higher missed approach speed at an intermediate altitude (*nominally 1000 ft AAL*).



Unfortunately, this has not been done in most cases. As such, to ensure terrain clearance in the missed approach when performance is marginal, the missed approach configuration and speed must be maintained to the nominated missed approach altitude, unless the aircraft is above a published MSA and can remain so.

The Boeing FCTM encourages pilots to accelerate at 1000 ft during a missed approach "during training". However, this technique is **not** applicable to single engine missed approaches, training or otherwise.

> Approach and Missed Approach — BOEING
> 777 Flight Crew Training Manual
>
> The minimum altitude for flap retraction during a normal takeoff is not normally applicable to a missed approach procedure. However, obstacles in the missed approach flight path must be taken into consideration. During training, use 1,000 feet AGL to initiate acceleration for flap retraction, as during the takeoff procedure.

Because of the obvious issues associated with teaching two different missed approach techniques depending on whether All Engine or Engine Out (*whether Visual, or Not; whether above MSA but below MAA, or not; etc*) – airlines typically elect to follow industry best practice and mandate acceleration at the published missed approach altitude, or when above MSA and terrain clearance assured – for all missed approaches.

That said ...

If the crew are required to level off prior to MAA, such as due to an ATC requirement, it usually makes sense for the PF to accept this as an opportunity to accelerate and clean up, rather than levelling and remaining in the missed approach configuration. Note the responsibility of remaining clear of terrain in this configuration/altitude still remains with the role of the Captain/PF.

It's been noted during two engine missed approaches - particularly when the aircraft is light - that **ALT** capture can occur early, well in excess of 1000 ft to level off, and the aircraft commences acceleration. This is "early" acceleration prior to MAA is acceptable, indeed desirable behaviour on the part of the AFDS and crew should continue this acceleration and retract flaps on schedule even though the aircraft may not yet have levelled at the MAA.

16.3. NAV UNABLE RNP – Go Around Navigation

Go-Around navigation from an RNP approach (***Note***: *this does NOT include RNP-AR approach procedures*) does not require the same approach ANP/RNP tolerance, and instead relies on an IRS coasting feature as a position solution. Since the approach design provides terrain separation for 2xRNP, the LNAV will be valid for a short time based on the drift rate, serviceability of the ADIRU and whether the satellites get back in view once a climb is started.

16.4. Go-Around Thrust Setting

The Boeing FCOM implies that single press TO/GA Thrust (FMA **THR**) produces a rate of climb of around 2000 fpm. On two engines this translates to at least 3000+ fpm once the pitch attitude has stabilised, often more. This is more than enough – especially with a low MAA – to be a handful at times for the PF/AFDS.

> **Automatic Flight - Go–Around**
> With the first push of either TO/GA switch:
> - roll and pitch activate in TO/GA
> - autothrottle activates in thrust (THR) to establish a minimum climb rate of 2,000 fpm

However at MAA when the AFDS transitions into **SPD** ... **ALT** – you now get thrust lever advancement as the aircraft pitches over to accelerate and the thrust is now limited by the annunciated EICAS N1/EPR thrust limit – typically GA at this point. Hang on!

16.5. Go Around Above DA/MDA/MAA – Take Your Time

Crew often have the mindset that a go-around must be actioned as soon as it's established that the criteria for continuing the approach no longer exists. Certainly, for a lack of visual reference at the minima – this is the case.

However for a go-around well above MDA/DH (*such as instructed by ATC, unstable at/before 1000 ft AAL, etc*); or for a go-around conducted early in the approach – especially when above the MAA (see **Missed Approach from Above MAA**) there's no rush. Continuing the approach – including the descent – for several seconds while you and your PM gather your thoughts and state your intentions for the missed approach can lead to a far better go-around that is often observed in these situations in the simulator. Just like almost every other event in aviation – there's no rush.

As a specific example – while a go-around is required when you are not stable on approach at 1000ft (*stabilisation height requirement*), there's nothing to say you can't continue that approach down to 800 ft while you and your PM quickly review the go-around/missed approach you're about to commence. This is NOT encouragement to continue an unstable approach to a landing – but a recommendation to take some of the time you have available and not rush un-necessarily into the go-around/missed approach.

16.6. Rejected Landing Procedure

A rejected landing is a manoeuvre performed when crew decide to action a go-around after the aircraft has touched down – reasons for this are few but included in them would be a late landing with potentially insufficient runway to complete the landing roll safely.

Note that this could occur after speed brake deployment, but prior to reverse thrust application. **The application of the reversers commits the aircraft to the landing**.

While the FCTM documents **Go-Around after Touchdown**, the following points should be noted about the Boeing procedure.

> BOEING
> 777 Flight Crew Training Manual
>
> **Go-Around after Touchdown**
>
> If a go-around is initiated before touchdown and touchdown occurs, continue with normal go-around procedures. The F/D go-around mode will continue to provide go-around guidance commands throughout the maneuver.
>
> If a go-around is initiated after touchdown but before thrust reverser selection, continue with normal go-around procedures. As thrust levers are advanced auto speedbrakes retract and autobrakes disarm. The F/D go-around mode will not be available until go-around is selected after becoming airborne.

- Go-around after touchdown, continue with normal go-around procedures (refer FCOM NP and QRH MAN)
- After touchdown the TOGA switches are inhibited and thrust must be manually advanced
- As per the 'normal go-around procedures' there should be no delay in the advancement of thrust, call and selection of Flaps 20, and rotation to go-around attitude
- With either thrust lever at the "takeoff thrust position" the speedbrake lever should stow to the DOWN position, and all speenbrakes should retract. This must be verified by the PM.
- Be aware the stabiliser trim may not be set correctly and control forces may be unusual during rotation
- A take off configuration warning may be generated if/when thrust is advanced with landing flap selected
- After airborne, TOGA switches will probably be required to provide appropriate F/D guidance

16.7. Clean up, before trying again

There is a tendency in the simulator training environment after a missed approach to leave the aircraft at Flaps 5 in anticipation of a short radar vector to final, minimising time and fuel expenditure. This is a simulator-training fixation that has no place on the line or in simulator LOFT line training.

After any missed approach at a major airport (*where else is a 777 going to operate to?*) the chances of being radar vectored a few miles after the missed approach, round to a 6-mile final at 1500 ft AGL are slim to none at best. In the case that this does happen, the chances of being in the right place at the right configuration and speed – with checklists complete, cabin and passengers updated, FMC setup complete, approach briefing updated as necessary **without error** is also pretty slim. Keeping flaps extended can also expose the aircraft to prolonged flight in icing conditions with the flaps extended, which is less than ideal.

Instructor involvement/interference (*flight freeze, position freeze, repositions*) notwithstanding – the best course of action is usually to clean the aircraft up completely, run the **After Takeoff Checklist** and prepare for a more successful second approach. Fuel notwithstanding of course …

16.8. Missed Approach Climb Performance

The Boeing QRH and FCOM PD/PI is a little thin on for single engine performance capability at non-standard climb gradients. Hopefully your airline provides data for this – similar to that shown here for your fleet(s).

You'll want data for Engine Inoperative climb data in both Flap 20 ("**Go-Around … Flap 5**") and Flap 30 ("**Go-Around … Flap 20**") approaches. The gradients selected need to represent the non-standard gradients found on the approach charts at Destination/Alternate airports on the 777 network.

Go-Around Flap 20

Applicable to all B777 Primary, Alternate, Adequate and Emergency Aerodromes

Elevation ≤ 600ft AMSL

	Missed App Gradient (%)	<10°C EAI	<10°C EAI+WAI	<10°C ICE ACC	MLW Limit Temp (°C)	MTOW Limit Temp (°C)
B777-300ER (MLW = 251,290kg) (MTOW=351,534kg)	2.5	MTOW	MTOW	336.1	50	31
	2.8	350.1	348.0	327.7	50	Contingency
	3.0	344.0	341.9	322.5	50	Contingency
	3.3	335.3	333.2	314.9	50	Contingency
	3.5	329.7	327.6	310.0	50	Contingency
	4.0	316.8	314.7	298.2	49	Contingency
	4.3	309.2	307.1	291.9	48	Contingency
	5.0	293.0	291.2	278.6	44	Contingency
	5.3	287.2	285.5	273.3	42	Contingency
	5.5	283.5	281.8	269.9	41	Contingency

Contingency

Where the word "Contingency" appears, the implication is that the aircraft is not certified to meet the required performance gradient (*usually hot/high* ***and*** *heavy*); choices at this point include:

- In VMC the Captain can choose to manoeuvre clear of terrain visually; or
- Apply a higher minima which will therefore require a lower climb gradient; or
- Use a Takeoff Performance Calculation engine failure procedure for that runway. You would need to run a takeoff solution at your anticipated landing weight to ensure adequate performance – and ATC would need to be advised, since you won't be following the standard missed approach procedure.

16.9. Go-Around – Auto LNAV Engagement

A feature in the Boeing AFDS arsenal is the **TOGA** to **LNAV** feature. Essentially during a Go-Around, LNAV will automatically arm-and-engage if the aircraft is within the capture criteria of an active leg. This feature minimises workload during the missed approach, as long as the missed approach path is available in the FMC during the go-around. Note that auto LNAV engagement can happen as low as 50 ft AGL during manual flight and 200 ft AGL with the AP engaged. Finally, TOGA to LNAV is a requirement for various aspects of RNAV/RNP/AR Approach certifications.

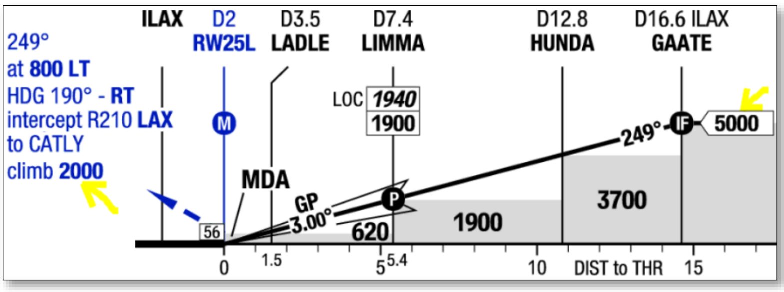
This feature has an obvious impact on the standard calls of a Go-Around since LNAV will engage very quickly during a Go-Around and should be called as an FMA change.

Additionally, note that if a missed approach is flown because of a Windshear, LNAV will auto engage and command a turn to follow the missed approach path against the Windshear Memory Items of wings level. This will also occur during a Terrain Escape manoeuvre if the TOGA switch is accidently selected (*ask me how I know this …*).

In the event of a circling approach, LNAV may well engage and provide guidance in the direction of the missed approach path, even if the aircraft is not near the missed approach point and therefore the guidance provided by the FMC through LNAV is not valid. Many missed approach paths are directional in nature (*track 160°, climb 4000 ft*) and do not include a reference to the MAP – hence where ever the aircraft is, it will turn towards 160° in the shortest direction. In this event, PF should engage another AFDS lateral mode to control aircraft flight path towards the missed approach.

Finally, the PF should also be aware that if an Engine Out TAC off ILS is flown with a Go-Around, the AP will disengage rudder control at auto LNAV engagement, and PF will be required to make asymmetric rudder inputs in response to asymmetric thrust, just after pressing the TOGA switch.

16.10. Missed Approach from Above MAA



KLAX has initial approach altitudes well above the missed approach altitude. As such in the event of a missed approach prior to the MAA, **it's expected that crew will continue the approach descent towards the MAA as part of the missed approach manoeuvre**. This presents a few interesting divergences from the standard go-around/missed approach manoeuvre.

Firstly, the TOGA switch is a no-no. You do not want a climb, you do not want go-around thrust. This applies whether flying a Precision or Non-Precision approach. Because of the variables involved (*current altitude, current MCP selected altitude, current FMA, type of approach, etc*) a single defined procedure may not apply. This is not a difficult manoeuvre, but it certainly benefits from a little thought and briefing prior to the approach to ensure both pilots are working from the same play book. How many times has that been said **after** a manoeuvre …?

<table>
<tr><th colspan="2">Precision Approach</th><th>Non Precision Approach</th></tr>
<tr><td colspan="3">• Set MCP Altitude Selector to the MAA (2000 in example above).</td></tr>
<tr><td>If APP is engaged

(GS and LOC)</td><td>• De-Select APP mode.
• AFDS FMA will revert to default Pitch and Roll Modes*
• Select either LOC or LNAV to ensure accurate lateral tracking.
• Use VS/FPA (default mode*) to continue descent to MAA.</td><td></td></tr>
<tr><td colspan="3">• Once the AFDS has captured MAA, increase selected speed for the missed approach (250 Kts? Flaps Up Speed?)
• PF can call "Go-Around, Flap 20" and a more conventional missed approach procedure can commence:
"Positive Rate", Gear Up, Flap Retraction, etc
• Do not select the TO/GA Switches.</td></tr>
<tr><td colspan="3">* Approach Mode de-select will only work above 1500 ft RA.
* Default Roll Modes is TRK or HDG HOLD if Angle of Bank is ≤ 5° - otherwise ATT will be the engaged lateral mode.
* Default Pitch Mode is VS or FPA</td></tr>
</table>

16.11. PRM Breakout Handling

Precision Radar Monitoring procedures involve aircraft on instrument approaches to closely spaced parallel runways in close proximity in IMC. What could go wrong?

Breakout alerts are advised by ATC and in the US may be preceded by an advisory alert warning of an aircraft entering the transgression zone.

The following points should be considered in relation to a PRM Breakout Manoeuvre.

US/FAA PRM Breakout Traffic Alert	Australia ILS/PRM Breakout
"**TRAFFIC ALERT, (aircraft call sign) TURN (left/right) IMMEDIATELY, HEADING (degrees). CLIMB/DESCEND AND MAINTAIN (altitude)**".	"**Breakout alert, (call sign), turn (left/right) immediate, heading (…). Climb/descend to (altitude).**"

ILS PRM Breakout Procedure	Pilot Flying	Pilot Monitoring
1	• Disconnect Autopilot. → • Leave Autothrottle Engaged.	• Set the Breakout Heading. • Set the Breakout Altitude. • Re-Cycle Flight Directors.
2	• Verify MCP Heading and Altitude Set. • Call " **Engage Heading Select** " and turn to assigned Heading. → • Call " **Engage Flight Level Change** " and commence Climb/Descend/Maintain.	• Select HDG SEL and FLCH. • Read back breakout heading and altitude requirements to ATC.
3	• Continue to fly the breakout procedure and accelerate/configure the aircraft as required. • TO/GA may be available (*and recommended*) once established on the breakout heading of a climbing breakout.	• Configure the aircraft as directed by the PF. • Monitor aircraft heading, speed and altitude.
4	After the aircraft is established on the breakout heading : • Re-engage the Autopilot as required.	

- For at least the initial turn and potentially the initial climb / maintain / descent, the AP must be disconnected, and the manoeuvre must be hand flown.
- With the Flight Directors cycled (Both OFF; then Both ON) the A/Thr should be in **SPD** and therefore speed protection for any subsequent manoeuvring is provided by the Autothrottle.
- Use of the TO/GA switch is not recommended until established on the breakout heading, and only then for a breakout climb to altitude. TO/GA is not applicable to a Descent/Maintain Altitude Breakout.
- Once the basic Aircraft/AFDS Flightpath is sorted – if TO/GA is available and that's your mode of choice – call " **Go-Around, Flap 20** " and commence a normal go-around procedure. Watch out for LNAV auto engagement, as this may command a turn away from your required heading. The aircraft should accelerate at altitude capture - otherwise continue the climb until **ALT** capture; then call for a speed increase, retracting flap on schedule.
- Use of TO/GA may engage TO/GA to LNAV, depending on the availability of an LNAV track. In this case a second application of TO/GA my not resolve the problem. In the event of an inappropriate TO/GA to LNAV, re-engage HDG SEL for the breakout heading.
- Clean up after the go-around should not take place until the breakout altitude is reached. The usual early acceleration option as per the A1 (MSA, etc) is available if relevant.
- Note that the use of FLCH will select CLB/CON thrust, which should be sufficient for a two engine / engine out go-around under most conditions.

16.12. Go-Around, Diversion and VNAV Cruise Altitude

It's a useful axiom to remember that VNAV is pretty good at doing what we do all the time. Takeoff, Climb, Cruise, Descent, even Approach (sort of). VNAV manages these well and is easily manageable in these phases – most particularly when tied to LNAV and the FMC defined route. Non-Precision Approaches, well they're ok but there are clearly some user experience gaps there.

For more unusual events such as a quick return or a diversion typically the best first response reaction to these events is to return your aircraft to basic modes (FLCH, ALT, HDG SEL) while you sort out your lateral and vertical path in the aircraft and the FMC before considering a return to higher levels of automation.

Go-Around and Diversion to Alternate

Diversions are another tricky area. The 777 FMC is almost incapable of planning a diversion ahead of time – at least as compared to what is achievable with a 25-year-old Airbus FMC. Yes, you can stick a destination SID, Route, STAR and Approach into Route 2 – but you can't performance predict, and activating that route is something best done while not still in LNAV/VNAV as the results can initially be unexpected to say the least.

Meanwhile the behaviour of the FMC VNAV Cruise Page Altitude as a result of a go-around tends to defy explanation. Part of this is the total lack of information as regards Go-Around and the FMC in the FCOM and Honeywell FMC guide.

Once a go-around on approach is initiated, any further descent constraints in the LEGS page are deleted, and the FMC Cruise Altitude is set to the higher of MCP Altitude or LEGS page Missed Approach Altitude. If the inactive Route is subsequently activated, the highest descent constraint is set as the Cruise Altitude when the route is activated/executed.

It's likely that for all but the shortest of diversion sectors – none of these altitudes are going to suit for VNAV engagement. Hence, it's recommended that before you engage VNAV after a go-around, check your default FMC VNAV page (*Climb / Cruise, or possibly even Descent*) along with command speed and any LEGS page restrictions first. It's almost certain that your cruise altitude will require modification to match your diversion altitude.

This scenario is one of the few times when the FMC Cruise Altitude can (*have been*) set to an altitude below that of the FMC LEGS page descent profile restrictions. This occurs in relation to a conflict between the go-around altitude vs the descent altitude restrictions in the inactive route diversion plan. Should you end up with this scenario – best to correct your cruise altitude and ensure your LEGS page restrictions remain intact. This is the one instance where use of the DESC NOW prompt will clear out any LEGS page altitude restrictions that are higher than your Cruise Altitude. Be warned.

17. After Landing

17.1. Autoland – Disconnect AP before A/Brake

SQ Munich Incident

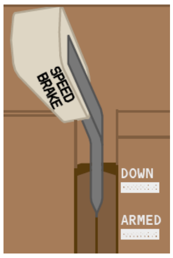
- YouTube
- Factual Report

During an Autoland, there is a potential threat to aircraft control if the Autobrake is disengaged and manual braking is commenced without AP disconnection. In this situation, the AP drives the rudder pedals to keep the aircraft on the centreline, while the pilot uses the rudder brake pedals to slow the aircraft.

In crosswinds if the aircraft begins to drift off the centreline, the AP will apply rudder to keep the aircraft straight. This will bring the drift side rudder pedal back towards the pilot, implicitly increasing braking on that side (*as well as decreasing braking on the other*) – exacerbating the runway drift – to which the AP will only increase the rudder application. Eventually this leads to either a runway excursion or an AP disconnect and sudden rudder input to the aircraft.

This is particularly true when conducting line training Autolands for practice or (*outdated*) regulatory requirement in crosswinds that you don't usually experience in Cat II/III conditions. Be warned.

17.2. Speedbrake Lever – Captain Initiates After Landing Flow



The PM After Landing Flow (*beginning with the consideration of APU start, ending in the EFIS CHKL button*) should not commence until the Captain has stowed the Speedbrake Lever after landing. Ideally this initiating action should not take place until the aircraft is clear of **all** active runways, and onwards taxi clearance has been received and briefed/discussed/understood between the two pilots. At this point, the Captain should stow the Speedbrake Lever and the PM After Landing flow can commence.

Note that if the aircraft clears the active runway and is then brought to a halt between runways, Speedbrake stowage and the After Landing flow can commence at the discretion and good judgement of the crew.

17.3. Towed Onto Stand

Some parking stand environments do not permit the crew to taxi the aircraft into position. The aircraft is marshalled to a position short of the stand - whether clear of the parking environment or just short of the correct parking position.

Once marshalled to the initial stopping point, the parking brake should be set and assuming the APU is available, the engines shut down. It should be noted that if there is any doubt about the ability of the tug to shift the aircraft (*such as uneven tarmacs with a history of problems in this area*) then the engines may need to be left running.

The seat belt signs should remain ON, the passengers seated, and the shutdown flow delayed until the parking brake is set after the aircraft comes to rest on stand. If not already done, don't forget to advise the cabin crew to disarm doors and cross check during the tow into stand.

Some Captains may choose to advise the passengers of this procedure during the descent PA; or an alternative is a quick PA from the First Officer/PRCM/SRCM as the aircraft initially comes to a halt to ensure the passengers obey the seat belt signs and remain seated.

17.4. Parking Brake & the Shutdown Checklist

The intent of the SOPs is that the Parking Brake will be released shortly after engine shutdown, once the ground engineer has confirmed chocks are in place. The Captain will release the parking brake ensuring the aircraft doesn't roll – after potentially considering the slope and slickness of the ramp. Then the cabin doors will be opened. It's worth noting that releasing the parking brake during passenger deplaning can potentially result in aircraft movement that may have an unforseen negative result – although there is no specific limitation on doing so.

However sometimes you never get the magic phrase from the engineer and you're left hanging with the Parking Brake Set. The issue here is that you must subsequently ensure that chocks are in fact in place and release the Parking Brake – or obtain a positive aircraft handover to engineering, advising them the Parking Brake is still set. Otherwise residual hydraulic pressure will be bled away by the Parking Brake until the accumulator is emptied, at which point the aircraft could roll away …

SHUTDOWN CHECKLIST

Hydraulic Panel	Set	F
Fuel pumps	Off	F
Parking brake	___	C
Fuel control switches	CUTOFF	C

Typically the Shutdown Checklist is then completed with "Set" as the response to the Parking Brake. An alternative to this is to hold the Shutdown Checklist until positive confirmation is received of chocks in place, Parking Brake Released.

17.5. CFP Completion Post Flight

Completion of the CFP as a Flight Log is both a CAR and SOP requirement. The Landing (On 19:06) and On Blocks (In 19:24) time values are completed after the aircraft generates an **In** event (*fuel controls in cutoff; parking brake set; first cabin door opened*). The fuel block should also be completed with Arrival Fuel (*Fuel Over Destination FOD*).

RAMP	16:01	135215	135.8
FOD	01:21	8399	8.5

	SCHED		PLAN	REV
STD	03:40	ETD	03:40	03:45
TKOF	04:10	TKOF	04:10	04:00
LAND	19:19	LAND	19:19	19:06
STA	19:25	ONBLKS	19:25	19:24
ETA	19:09			

18. Diversions

18.1. General

This section incorporates some common sense, practical points on the area of diversions. Because of the varied natures of an in flight (or end of flight) diversion, crew need to use common sense and airmanship in all aspects of diversion planning and execution.

18.2. Parking – Nose In?

One common issue in a diversion is accepting a nose in stand (*or any other stand that precludes the ability of the aircraft to depart the apron without assistance*) without first ensuring a 777 rated push back tug is available. Because of the potential high weight of the 777, tug availability can be limited in airports that don't usually handle the aircraft. It's worth noting that even when the departure weight will be significantly reduced (such as recovery after a diversion at destination) a tug that can push a 767 at maximum weight may not be available to push the 777 at a lesser weight, particularly in first world countries.

18.3. ADIRU & SATCOM

Sometimes, the SATCOM can be your best friend during a diversion, enabling instant contact across the world to Operations, and across the airport to the ground staff, refueller, ATC or engineering. SATCOM depends on the ADIRU, so consider leaving the ADIRU on until you're sure you don't require SATCOM.

19. Document Revision Details

Document Revision Details	Issue Date : 23.Feb.20
23.Feb.19	Initial Issue (ten year after I started writing …)
23.Feb.20	All significant changes and new content are identified by highlighting in the HL version of the document. Besides this – there are many cosmetic, grammatical, spelling and reference changes to the document which are not considered operationally impactful to the intent or content and therefore are not highlighted.